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CONVERSION OF BLUE PINE FOREST TO DEODAR IN THE BASHAHR DIVISION OF THE PUNJAB.

BY H. M. GLOVER, I.F.S.

A short note on the Nankhari Plantation may be of interest as it illustrates the transformation of a pure blue pine (*Pinus excelsa*) wood to an almost pure deodar (*Cedrus Deodara*) crop.

The plantation lies at an elevation of from 7,500 to 8,200 feet in the Nogli Range on an eastern slope of moderate steepness, and consists of about 145 acres and has cost Rs. 20 per acre to establish It was commenced in 1900-01 when a nursery was started, deodar transplants first being put out in July 1902 under blue pine shelter-wood. At that time the area was covered with a dense blue pine wood which consisted chiefly of mature blue pine with some patches of smaller timber and a fair amount of advance blue pine reproduction. The first fellings for export were started in 1902 and Mr. MacIntyre, the then Divisional Forest Officer, anticipated that the cover would be removed within five years by which time the deodar plants would be established.

Successful plantings were followed by sowings in patches under the shade of the surrounding blue pine, and the work was extended by Mr. Hart beyond the scope of the original proposals till deodar seedlings were successfully established over about 145 acres. A period then intervened in which throughout the Punjab the policy of converting blue pine woods into deodar was discontinued on account of the rise in price of blue pine timber, and in common with the other plantations in the Himalayas the Nankhari plantation was left to itself for some years, the plants for the most part being kept free from undergrowth while fellings in the blue pine overwood were suspended. By the end of 1914 the growth of the deodar transplants and seedlings showed the most marked differences according to their freedom from overhead cover. Where the cover had been sufficiently opened the saplings were flourishing and about 10 feet high, but where the blue pine cover had not been heavily lightened they were stunted, often not more than 2 feet in height and unhealthy, being attacked by a fungus resembling canker, which girdled the leading shoots and caused eruptions on the bark of other branches, the whole plant often being covered with numerous sores.

A heavy clearance of the blue pine overwood was started in the beginning of 1915, and the following winter the present Inspector-General of Forests asked for the plantation to be treated as an experimental area irrespective of the financial results from felling the blue pine wood. Heavy fellings were made in 1916 and the results on the growth of the deodar have been most marked: plants which had been suppressed for years are now growing rapidly making over 2 feet a year in height growth and the fungus attack is rapidly disappearing. Further heavy fellings are now being made and by the end of the (1918) working season the whole of the blue pine shelterwood will have been removed with the exception of a few blue pine trees with high crowns left to fill up occasional blanks.

The total cost has amounted to Rs. 20 per acre and further tending may eventually carry the cost to Rs. 25 per acre when conversion from pure blue pine to practically pure deodar will have been completed.

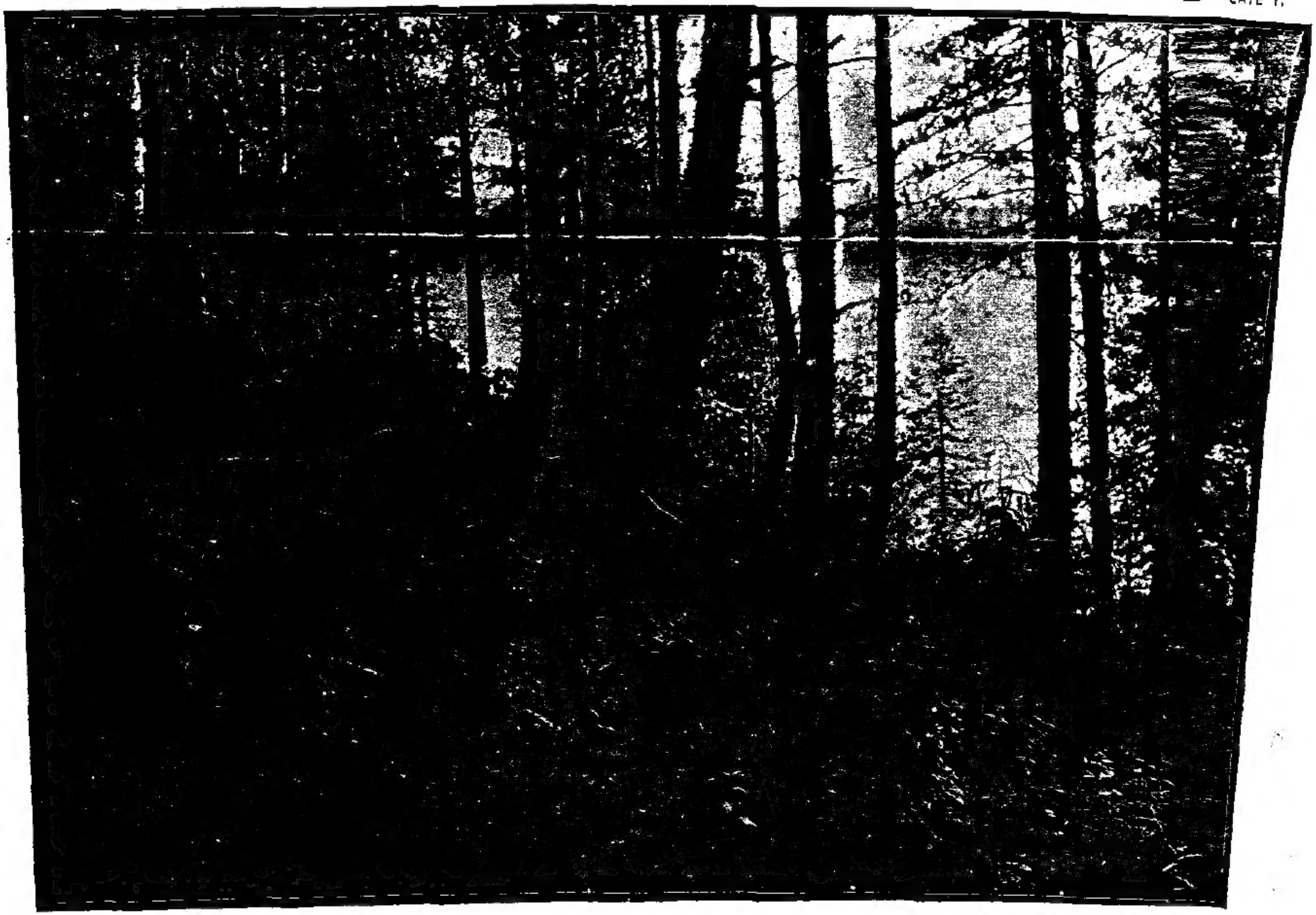

Photo.-Mech. Dept., Thomason College, Roorkee. Photo by R. S. Troup, I. F. S. June 1914.

Showing part of blue pine shelterwood insufficiently thinned out. Deodar 2 to 4 feet high and 12 years old.

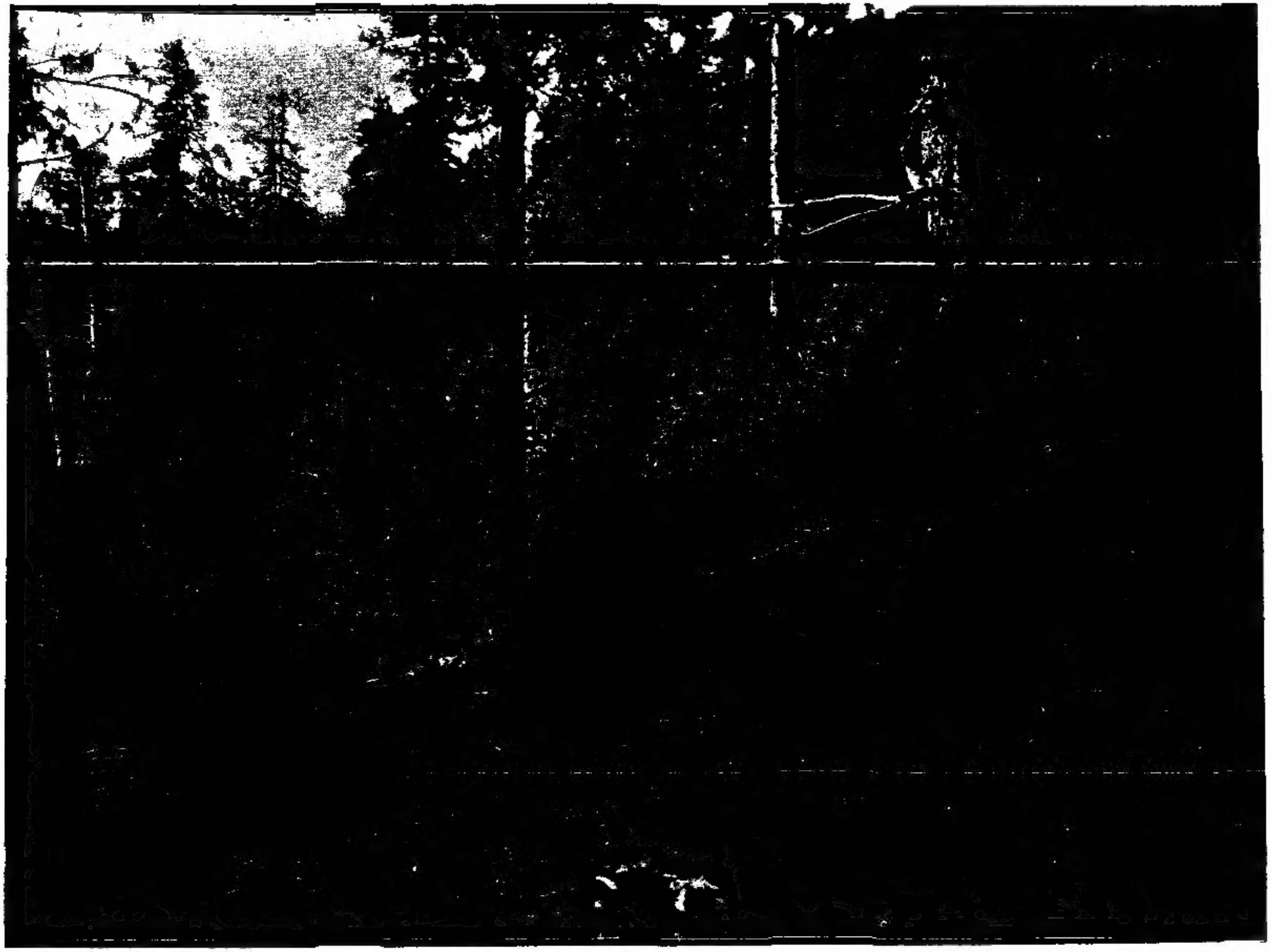

Photo.-Mechl. Dept., Thomason College, Roorkee. Photo by R. S. Troup, I. F. S., June 1914.

Showing part of plantation where blue pine shelterwood had been heavily opened out.
Deodar 7 to 10 feet high and 12 years old.

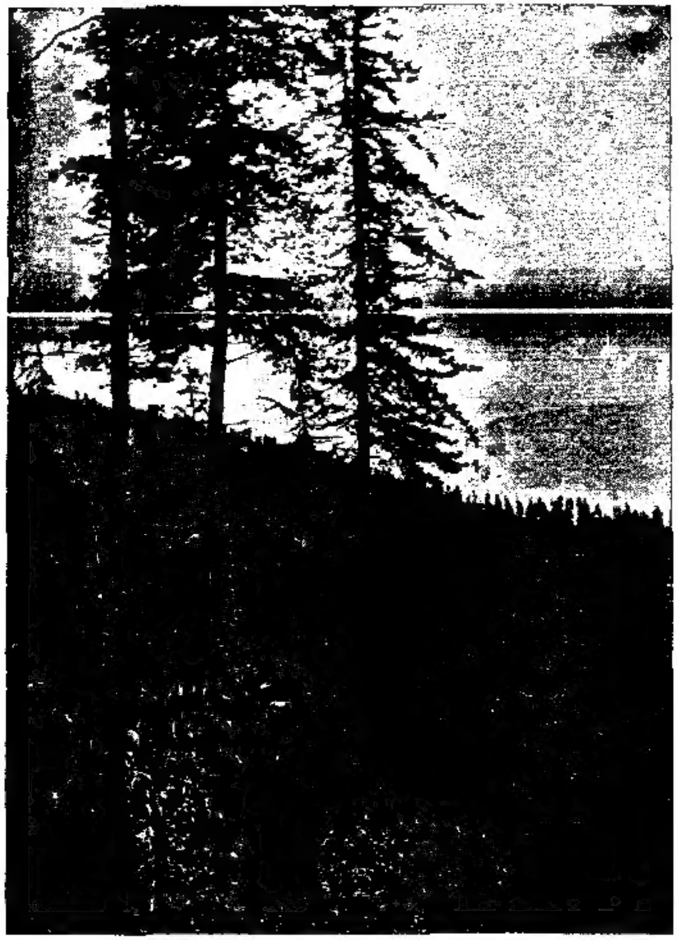

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 1.—The last of the blue pine shelterwood. August 1914.

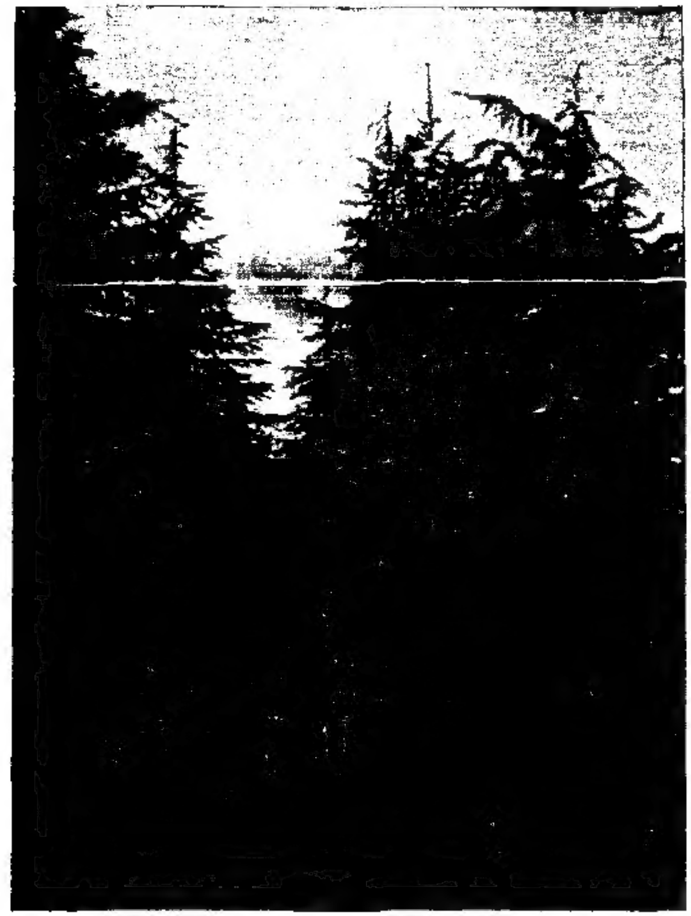

Fig. 2.—The blue pine cover completely removed. Deodar 18 years old and well over 20 feet in height.

From the experience gained with this and other plantations in both Kulu and Bashahr the present policy of dealing with blue pine woods in the Bashahr Division has been evolved. Blue pine woods are often affected by *Trametes pini*, which renders the timber unfit for export and in such areas conversion to deodar is aimed at.

In addition in mature blue pine woods felled over in regular regeneration fellings, deodar seed is sown in order to render the young woods as rich in deodar as possible.

The overwood is marked in a heavy seeding felling, débris and bushes are burnt and the ground is hoed to the depth of one foot in patches 5′ × 2′ in size and 5 feet apart, and deodar seed is sown in November. From these patches transplants are put out in the surrounding blue pine shelter-wood and blue pine seedlings are allowed to come in naturally, the deodar being favoured at the expense of the blue pine in subsequent tending operation.

The blue pine mature crop makes an excellent shelter-wood for the young deodar, but after about three years the cover has to be heavily lightened and completely removed once the deodar plants have properly established themselves which takes about five years from the first sowings. It is expected that the total cost on débris clearing, hoeing, sowing and tending till established will not amount to more than Rs. 15 per acre.

THE EFFECT OF JHUMING ON SAL.

BY A. N. GRIEVE, I.F.S.

The *whole of the forests of the Singhbhum* Division are situated in a vast mass of hills which rise up to 3,000 feet and are cut up by innumerable rivers, streams and ravines into steep, narrow valleys; the tops of the hills are usually narrow, but occasionally are flat-topped and form plateaus of varying extent. The topography *is somewhat similar in* the neighbouring Feudatory States of Bonai and Keonjhar to the south and south-west.

Before the reservation of these forests this large tract of jungle-clad hills including the adjacent parts of Keonjhar and

THE EFFECT OF JHUMING ON SAL.

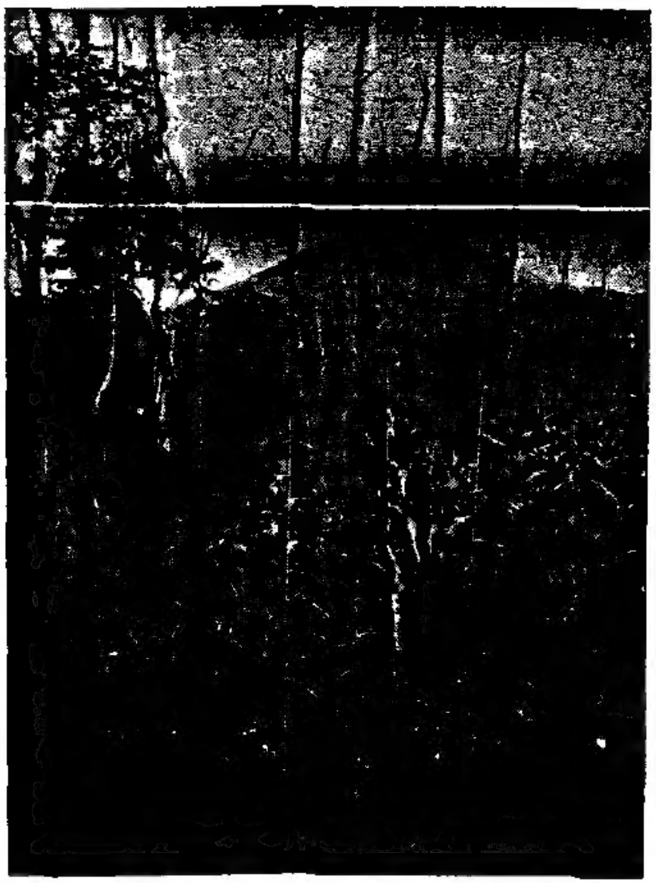

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 1.—Sal pole forest killed by Jhuming with crop of "gungai" (millet).

Fig. 2.—Sal poles killed by Jhuming. The foliage on the trees is a kind of leguminous creeper.

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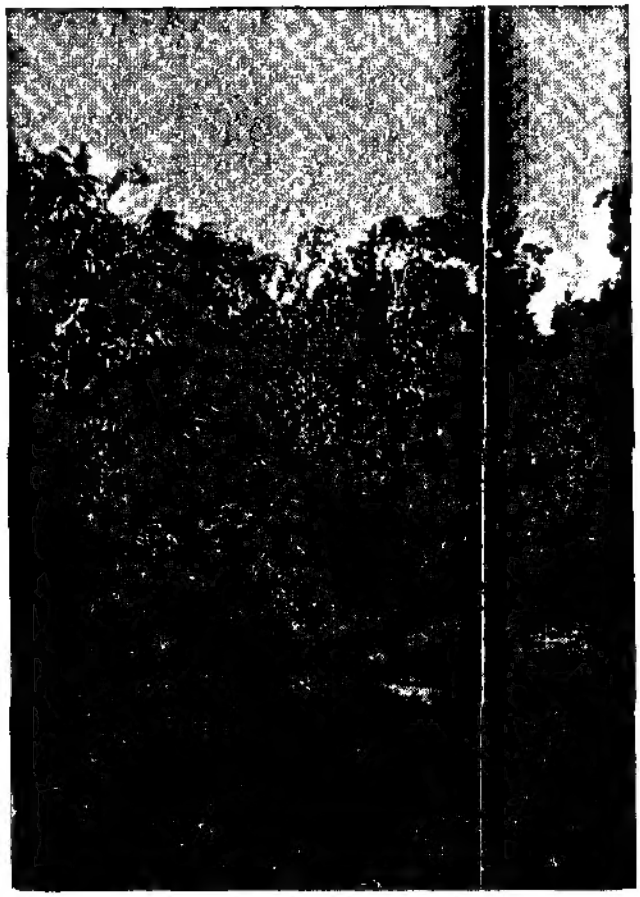


Fig. 3.—Secondary growth of various species, but chiefly *Woodfordia floribunda* coming up as a result of repeated Jhuming.

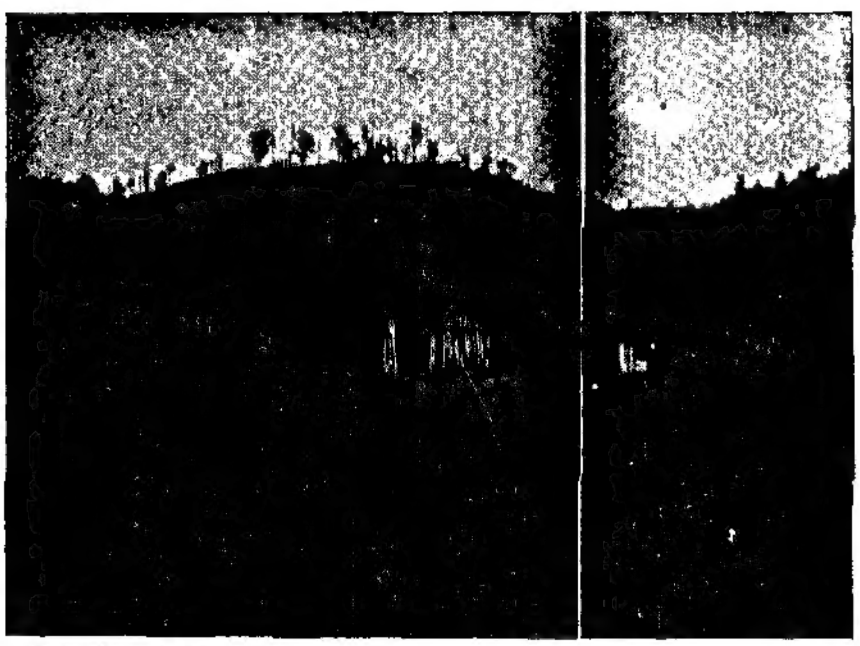


Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 4.—General view of a repeatedly Jhumed hill. Chiefly Mohwa and other fruit trees left.

Bonai, and especially the latter, was inhabited by a small population of Kols, in villages scattered about throughout the jungle. The villages were small in point of the number of inhabitants and cultivated areas, but very large in point of area, the boundaries being quite indeterminable and sometimes embracing an area of as much as 20 square miles.

The chief form of cultivation was jhuming, and only in the most favourable localities was a little permanent cultivation practised. As the population was small and the area of jungle very large, the area to be jhumed was changed every 2 or 3 years and a fresh area of jungle was cut down, the same area not being cultivated more than three years in succession, and would not be returned to until an interval of 15 to 20 years or so had elapsed.

The greater part of these forests was declared reserved in the years 1884 and 1888 and the villages which were left in the forest were demarcated and many of the smaller ones were evacuated and their inhabitants settled in the neighbouring states where they could practise jhuming to their heart's content and continued to do so, without let or hindrance, until the settlement of Bonai took place in 1912-13 and that of Keonjhar about 1913-15.

During the writer's incumbency of the post of Agency Forest Officer of the Orissa Feudatory States he had frequent opportunities of observing the effects of jhuming on Sal, which may best be described by following the process from the time when virgin Sal forest is first jhumed down to the disappearance of the Sal.

When an area containing virgin forest is attacked, the larger trees are ringed and piles of dead wood are heaped round the stems and burnt to hasten or make sure of their death, the result being a forest of standing dead trees and poles (Plates 4 and 5). Most of the smaller trees (a few sometimes are left for the following year) are cut down and burnt in order to manure the field crops. The process is repeated the following year and possibly for a third year, the small coppice shoots being cut down each year and burnt during April or May. The area is then abandoned for another piece of jungle, and is left for perhaps 20 years by which time a fine crop of Sal saplings or poles has grown up—resulting

not from fresh seed—as usually all the mother trees have been killed, but from previously established regeneration and coppice shoots from the smaller trees. This is, without doubt, the origin of the many fine crops of even-aged Sal poles which are found throughout the Singhbhum Division, an additional proof being that they are always found on the sites of old deserted villages, and frequently some of the old ringed trees, with the ring mark still visible, are found among them. After the period of rest—the period depending largely on the density of the population and the amount of jungle available, the smaller the population and the larger the area of jungle the longer the period of rest—the same area is again jhumed over for another 2 or 3 years in succession, and after this second jhum the crop of Sal will be found to be considerably thinner, many of the stools being killed out, and probably a certain amount of grass, *Wendlandia exserta*, *Woodfordia*, *Trema politoria*, etc., will have made its appearance. As the process goes on, the proportion of Sal declines and that of the above-mentioned species increases as also does the grass, until finally all tree growth is killed out and only grass remains. This last stage is not reached for a long period and is usually due to a scarcity of jungle and a comparatively dense population, which results in the area being cultivated so frequently as to kill out even the secondary tree growth. Of the original species, Sal appears to be one of the first to disappear: and *Lagerstrœmia parviflora* and *Diospyros tomentosa* the last.

In many of the Orissa states, *e.g.*, Bonai, Keonjhar, Pallahara, Kalahandy (on the Madras border) the process is to be seen in all its stages from virgin forest to open grassy maidan, and when once Sal has disappeared it takes very many years for it to come back again. This may be seen in old deserted villages in the Singhbhum Division, some of which have been jhumed to the stage where only grass remains and have been left to nature for fully 30 years (*e.g.*, Baliba Rith in Samta Range). In this particular place, at any rate on higher ground, a thick growth chiefly of *Woodfordia* and *Wendlandia* has succeeded in making its appearance and has killed out the grass more or less, but only a very few Sal

seedlings have succeeded in establishing themselves here and there *under the shade of the secondary growth trees, and this after* 30 years; and on lower ground where rice had been grown, a rank growth of grass still persists.

Certain foresters advocate regenerating Sal forest by means of jhuming in the same way as teak is being regenerated by means of the taungya system in Burma. It would no doubt succeed admirably where there is already established Sal regeneration provided that agricultural crops were not taken off the area for more than two years in succession and preferably in only one year. Cultivation would have the advantage of eradicating weeds and creepers in damp localities, but it seems to the writer that equally good results would be obtained by clear felling over established regeneration and burning afterwards, if thought necessary or desirable. It is doubtful whether villagers would be willing to go to the labour and expense of cultivating an area for only one year.

Where regeneration is scanty or absent, the ground would no doubt be much benefited by cultivation, but Sal in this part of the country, unlike teak, under natural conditions takes several years to establish itself and even then requires a certain amount of shade, so that until a method can be found of getting Sal to establish itself quickly it is doubtful whether this method would succeed.

A PLEA FOR TEAK TAUNGYAS.

BY "LOTTIE."

To the best of my recollection it was about the year 1906 that the formation of Teak plantations with the assistance of the shifting cultivator was generally stopped in Burma. There are exceptions but in such Divisions it was not for love of the system that permission was given to continue the work. On the contrary, it will probably be found that before sanction to its continuation could be obtained other solid reasons were demanded.

Apart from actual objections to Teak Taungya plantations themselves, it was held that more good could be done to our

forests by concentrating the staff's attention on Improvement Fellings in favour of the existing young Teak regeneration. It was presumably assumed that the Teak natural regeneration was sufficient for our purposes providing that steps were taken to bring it through the overstanding bamboo and tree canopies. Exactly how the work of Improvement Fellings dealing with existing growth could have been regarded as a substitute for Teak Taungyas dealing with the regeneration of the species, I am unable to explain, but it is obvious from our experience of the past few years that the tending of advance growth of Teak seedlings, by means of freeing the overhead cover, is a very costly procedure quite incommensurate with the results obtained.

It has now been realized I think that the work involved in the interests of a few etiolated seedlings is no less than that of carrying out a Seeding felling, whilst the crop of young Teak resulting, under favourable circumstances, from the latter operation is an asset made more worthy of our care and attention than is that based on an advance growth which is very sparse and which, in most cases, comprises coppice shoots from semi-dry roots of any age up to 50 years.

We have no sooner obtained our seedling crop by means of practically a clear felling and final burning, however, than several foresters have remarked on the similarity of the results obtained to those resulting from our old and somewhat despised method of regeneration by the Teak Taungya system. Under the latter system we only paid by results, that is, we took no risk such as the seeding felling involves whilst the removal of the old wood cost us nothing. We had labour on the spot to carry out the weedings during the first year and, with a little organization, it should be possible to arrange for its continuity during the second and third year.

Being thus confronted with the possibility of a reversion to the old "taungya" method or with at least a change of methods before long, I have heard it said that if only we knew the secret of the origin of our existing teak forests, our path would be easier and that before making any further changes we should endeavour

to ascertain how they came into existence. It is my opinion that the general trend of affairs as above recapitulated should in itself be a sufficient ground for at least a partial reversion to the system of artificial teak plantations and if it were not for the damage done by the bee-hole borer and elephants I should be a wholehogger for a general resumption of the old method especially in those parts where any doubt exists as to the resulting crop of teak likely to be obtained from seed fellings. In some of the northernmost Divisions of Burma, I learn from Mr. Grieve's Inspection Notes that teak regeneration is assured wherever a taungya is cut in the vicinity of teak mother trees. I do not think that such conditions could be said to prevail generally and at least in Lower Burma there are many areas where the bamboo jungle is almost pure and where the introduction of teak by the taungya method is the only possible solution if the areas are to be brought on to a paying basis.

It was precisely in view of the doubt existing among some forest officers as to the origin of our teak forests that I set out to address you, Mr. Editor, and I must apologize for taking up so much of your valuable space before coming to the point. I should like to state that generally I have no difficulty in associating the origin of the existing crop with that of the work of the taungya-cutter. One of my principal relaxations when engaged in marking and girdling teak trees has been to prove to my own satisfaction, where possible, that each girdled tree either originated in, or is the result of, a temporary clearing, or that at least at some stage of its existence the tree had been tampered with by the taungya-cutter. I estimate that in one out of every two trees I manage to do this. The evidence in such cases is chiefly based on old partially girdled trees, remnants of the stumps of felled trees, low forked trees, and the basal indications of the coppice origin of the stems.

I recollect when carrying out my first girdlings in Burma, namely, in the Katha District, drawing attention to the even-aged character of the trees in patches and to the fact that lines or heaps of stones piled up on the edges of the original clearings reminded one of the rice field "kazins" or bunds, and clearly indicated the origin of the tree growth.

The fact must not be lost sight of that the teak is essentially a domesticated tree. It thrives best, at least most profusely, in the vicinity of men. The edges of cultivation often present the teak as an obnoxious weed and, if in sufficient quantity, it often closely resembles a plantation. No one would, I think, dispute the influence of the taungya-cutter in such cases. Permanent rice fields are only brought about by degrees. They commence as clearings over an extended area, and during the period of conversion and often afterwards it is essential that the cultivator should grow his own sessamum and curry stuffs on the adjoining high ground, besides adding to his rice outturn. Here again an examination of such teak patches will often reveal the old mother trees still standing, or failing which their stumps wil generally be traceable whilst the coppice growth from some of the smaller stumps leaves no doubt as to their origin.

A few years since I recollect proposing an area for reservation and classifying it as teak-bearing. It comprised a portion of the left bank drainage of a biggish stream and extended approximately over 40 square miles. My inspection of the area—it contained no internal cultivation—was limited to demarcating a line along the valley bottom so as to exclude the cultivation on that its western boundary. In this neighbourhood there were quantities of teak trees, and it appeared to me an opportunity for reservation which ought not to be lost. A few years later, however, I met the Working Plans Officer and was surprised to learn from him that the area contained practically no teak and that my demarcated boundary not only excluded the fields but most of the teak-bearing areas as well. In other words, so closely is the teak tied up with the villager's activities that if reservation be conducted with little or no opposition it may safely be concluded that that area contains little or no teak.

The annual provincial forest reports for Burma continue to show that a large proportion of our annual girdlings of teak trees is still obtained from the unclassed forests. This is partially due to the impossibility of separating the teak forests from the cultivated lands for the purpose of reservation under the Forest Act.

In the last Division of which I held charge there was admittedly more teak outside reserves than inside, but on account of the intensity of permanent cultivation along the streamlets, in many cases almost ascending to the ridges themselves, it is now impossible to obtain homogeneous forest blocks suitable for reservation. Moreover, the intervening spurs and hillocks are largely subject to shifting cultivation, and with the present high prices ruling for cotton it is no wonder that the area cut over increases from year to year. Theoretically, the teak-bearing areas are protected from "taungya" by law; but just as one swallow does not make a summer, so it is difficult to convince the Courts that a few teak poles per acre constitute a teak-bearing area within the meaning of the Act.

FOREST INSECT CONDITIONS IN GORAKHPUR DIVISION, U. P.

BY C. F. C. BEESON, M.A., FOREST ZOOLOGIST.

The Sal forests of Gorakhpur Division exhibit insect pest conditions of an unusual type, which appears definitely assignable to peculiarities of the forests themselves, and which, in many aspects, forecasts conditions likely to characterize intensively worked Sal divisions.

In view of the ultimate method of management of these forests a consideration of the insect pest conditions in the Sal coppice working circles may be of interest. (Attention is drawn to Mr. Marriott's account of the Sal forests of Gorakhpur, *Indian Forester*, Vol XLIII, 1917, pp. 442—456.)

The Sal coppice working circles are characterized by insect conditions which differ from those in Sal high forest in other localities mainly by the subordinate importance of heart-wood borers, shot-hole and pin-hole borers, and by the relatively increased importance of defoliators and pests of young growth.

The insect pest species occurring in the division may conveniently be classed under three heads, *viz.*, (A) Borers, *i.e.*,

bark-beetles, and flat-headed borers, shot-hole and pin-hole borers, and heart-wood borers; (B) Defoliators, *i.e.*, caterpillars, cockchafers and other beetles; (C) Pests of young growth, *i.e.*, cockchafer grubs, ants and other soil insects, grasshoppers shoot-borers and girdlers. The three groups are distributed irregularly through the age-classes.

(A) BORERS.

(1) *Clear felling Areas.*—The very intensive removal of felling débris, combined with the barking of poles and logs, prevents the continuance of almost all species of borers commonly found in Sal forests from the western United Provinces to Assam. The only species at present able to breed in felled material during the working season, and likely to form part of the permanent fauna of coupes, are *Sphaerotrypes siwalikensis*, Steb., the Sal bark-beetle, *Xylotrechus smei*, L. and G., a small sapwood longicorn, and *Xyleborus perforans*, Woll., a cosmopolitan and polyphagous pin-hole borer. These occur in fuel stacks and unbarked slabs, etc., but their presence is economically negligible.

The large and small heart-wood borers, *Hoplocerambyx spinicornis*, Newm., *Aeolesthes holosericea*, Fabr., *Diorthus cinereus*, Fabr., and *Dialeges pauper*, Pasc., together with a long series of shot-hole and pin-hole borers, species of *Xyleborus*, *Platypus*, *Diapus* and *Crossotarsus*, are (apparently) entirely absent; and the possibility of their epidemic appearance under favourable climatic conditions is relatively remote.

(2) *Cleanings and Thinnings.*—In coupes from the pole to the tree stages a slightly different fauna is met with. Owing mainly to the fact that there is an appreciable mortality of Sal trees of various ages, due to "Natural causes" (*i.e.*, exposure after cleaning and thinning operations, *Polyporus shoreæ*, local changes in the soil factors, etc.), borers with semi-annual and annual life cycles are endemic, in addition to the species with short life cycles. The most important of these is *Aeolesthes holosericea*; *Dialeges pauper* also occurs together with *Diapus furtivus*, a few minor shot-hole borers and Anthribidæ. The large Sal heart-wood borer,

Hoplocerambyx spinicornis, is either definitely absent or so rare as to escape notice.*

The writer considers that the absence of this borer is in complete agreement with the past history of these forests. It was undoubtedly present four or five hundred years ago, when the northern belt of submontane Sal forests was continuous with the present Sal areas of the Central Provinces. The extension of cultivation in the last century, with its accompanying heavy fellings, reduced the once continuous Sal forest of the Gangetic plain to the existing blocks of small areal extent, and produced conditions which led to the extermination of the species. The same state of affairs occurs in other isolated blocks of Sal forest in the plains of Gonda, Bahraich and Kheri. The principal factor working towards the elimination of *Hoplocerambyx spinicornis* appears to have been the decrease, almost to zero, of the annual death-rate of Sal in the isolated blocks of forest. This effect was produced by the reservation of the forests ; a cessation of fellings following on very heavy extraction (amounting in some cases to clear cutting), accompanied by fire-protection, reduced the amount of dead Sal per year in any one locality, below that required to maintain the species at its endemic incidence. This effect was further emphasized by the dissipation of the forest into small blocks too isolated to permit of infiltration of borers from neighbouring areas.

In the Sal forests of the submontane belt, reservation and closure to fellings failed to produce the same result, because the mortality of Sal was and is still maintained by extensive erosion in the numerous gullies and ravines which dissect the foot-hills. In all probability the Sal death-rate due to erosion has increased above the normal for virgin forests since the middle of the last century as a result of the denudation of the Nepal hills

* *Note.*—Sal logs felled in Gorakhpur Division at intervals from 1915—1918 and exposed to optimum conditions for attack by heart-wood borers, have been collected and railed to Dehra Dun in order to breed out the borer fauna in the Insectary. None yielded *Hoplocerambyx spinicornis*. In January 1918 the writer toured in the Division and conducted an extensive search for this species without finding a trace of its existence.

The operation of the factors cited above has been possible only in the case of *Hoplocerambyx spinicornis* because, firstly, that species is monophagous, breeding in Sal alone of the trees occurring in the U. P. jungles, and, secondly, its life cycle is annual. We find, therefore, that other borers such as *Aeolesthes holosericea Dialeges pauper, Xylotrechus smei* have survived because they are polyphagous, breeding commomly in half a dozen of the tree species associated with Sal, and because they develop by semi-annual generations which possess the faculty of lengthening the life cycle to a year if conditions are adverse.

Miscellaneous species.—The borers of the miscellaneous tree species associated with Sal, are, in addition to the polyphagous Sal borers mentioned above, all species of beetles of the families Scolytidæ, Buprestidæ, Cerambycidæ, Lamiidæ, Curculionidæ, and Anthribidæ. They are of minor ecomomic importance as affecting the timber or fuel of the miscellaneous trees, but it should be observed that the numbers of the principal Sal borers and shoot girdlers are maintained by the annual production of breeding material in the form of fuel and unconverted or unbarked logs of the less valuable species.

(B) DEFOLIATORS.

The principal defoliators in Gorakhpur Division are caterpillars of the following species :—

Ingura subapicalis, Walk., *Plotheia celtis*, Moore, *Suana concolor*, *Trabala Vishnu*, Lef. and cockchafer beetles, *Lachnosterna problematica*, Brenske, *Adoretus caliginosus*, Burm., *Holotrichia* spp. and *Serica* spp.

The maximum defoliation takes place in April, May and June in compartments of the pole stage and upwards and its economic importance is still a matter of conjecture. The defoliators of Sal have, up to the present, received little attention ; but it is probable that, with the extension of blocks of even-aged forest under the uniform systems, their economic effect will become more obvious and they will be reckoned as the principal pests of uniform forests, not only in this division but throughout the range of the Sal.

(C) PESTS OF YOUNG GROWTH.

(1) *Nurseries.*—As Mr. Howard has pointed out, the principal insect pests of Sal seedlings in nurseries are grasshoppers of the *Chrotogonus* group, which are accompanied by species of *Teratodes*, *Aedalus* and *Aularches*, together with brown crickets. These insects are strictly pests of agricultural crops and do not attain the grade of pests in forests until agriculture is practised as an essential part of the system of management. They occur in Sal nurseries in Gonda and other U. P. divisions while allied species occur in chir and deodar sowings in the Punjab. For their control the agricultural methods of bag-netting and trapping in ditches are necessitated.

The cockchafer grubs are principally species of *Holotrichia* and *Serica*, which occur in large numbers as part of the normal soil fauna of Sal forests containing undergrowth. Mr. Marriott reported in 1913 that at least 50 per cent. of the natural Sal seedlings are killed off by cockchafer grubs during July and August. The seedlings which survive are those which are able to produce strong side roots to replace the destroyed tap-roots. The success of natural regeneration is likely to be jeopardized in years following good mast years by the concordant increase of cockchafers; since not one but a group of species is present the increase in the number of grubs is inevitable. The greater reliance placed on artificial regeneration will necessitate a careful choice of the sites for nurseries and a thorough cleaning of the soil before sowing operations are commenced.

(2) *Coppice coupes of one to four years old.*—The principal pests of young coupes are stem girdlers which gnaw off the bark or girdle vigorous coppice shoots. The damage is done by the longicorn beetles, *Batocera rubus*, Linn., and *Plocæderus obesus*, Gahan, which breed in the wood of *Odina Wodier* and numerous other soft woods occurring as unbarked logs and stacks of fuel in thinned coupes. The present methods of working favour the progressive increase of these shoot girdlers, which even now are occasionally numerous enough to nullify the season's growth over large areas. It will, therefore, become necessary to avoid the

production of breeding material by the barking or early removal of poles and logs of the miscellaneous species felled in cleanings and thinnings.

The moth shoot-borer, *Pammene theristis*, Meyr., is at present not abundant in young coupes; as it bores in successive generations in the seed, seedling root, and young shoot of Sal it is certain to become a pest of considerable importance in the future.

Sal High Forest.—What has been said above with regard to the borers and defoliators of coppice coupes under thinnings applies equally to high forest in other working circles.

It should therefore be evident that the uniform system of working Sal has been introduced into Gorakhpur under circumstances which are unusually favourable from the aspect of insect pest control; that while, on the one hand, sylvicultural methods tend towards maintaining and increasing the danger from certain pest species, on the other hand, they tend towards the reduction and eventual elimination of the most injurious species; and that the control of the minor pests becomes more simple and feasible as the methods of management become more intensive and regular. Gorakhpur Division appears to epitomize the insect conditions that are likely to accompany the introduction of uniform methods of working Sal forests.

A NEW SPECIES OF *IXORA*.

In September 1917, Mr. A. J. S. Butterwick, Extra Assistant Conservator of Forests, sent specimens of an *Ixora* to Dehra Dun for identification which could not be matched there and which appeared to belong to a new species. Specimens of it were accordingly sent to Kew for comparison with the material there. In his reply Sir David Prain wrote that the specimens belonged to "an entirely new species of *Ixora* which may safely be described." The following is the diagnosis of the species :—

Ixora Butterwickii, Hole. Species allied to *I. spectabilis*, Wall., and *I. pendula*, Jack; from the former it differs in the larger size and shape of the leaves, more numerous lateral nerves and wider

panicle; from the latter it differs in the shorter corolla tube, longer anthers and wider panicle.

Ixora Butterwickii, Hole. Species *I. spectabili*, Wall. et *I. pendulæ*, Jack, affinis; ab illa dimensionibus majoribus figuraque foliorum, nervis lateralibus numerosioribus et panicula latiore differ; ab hac tubo corollæ breviore, antheris longioribus et panicula latiore recedit.

The species is a large shrub with crimson flowers and is at present only known from the Palwe Reserve in the Yamethin district of Burma. A full description and illustration of it will shortly be published in the Indian Forest Records. The writer has much pleasure in naming this plant after Mr. A. J. S. Butterwick, who has steadily endeavoured to apply in the forests of Burma the botany he learnt during his training at Dehra Dun and to whom we are indebted not only for the specimens of this species but for much valuable material which he has sent to us from time to time. The writer also desires to tender his warm thanks to Sir David Prain for kindly having our specimens compared with the material at Kew, also to Colonel Gage and Mr. C. C. Calder for very kindly sending to Dehra Dun the Calcutta material of *Ixora spectabilis*, Wall., and *Ixora pendula*, Jack, for examination.

R. S. HOLE,
Forest Botanist.

Dated 14th December 1918.

THE EFFECT OF THINNINGS ON A YOUNG TEAK PLANTATION.

BY J. D. CLIFFORD, I.F.S.

In order to provide for the students of the Burma Forest School a practical demonstration of the beneficial effects of thinning a young teak plantation, two adjacent sample plots of one acre each were laid out at the end of July 1913 in a 17-year old plantation in the Pyinmana Division. The plantation had not previously been thinned and was of medium quality. Sample

Plot No. 1 was cleaned but not thinned and Sample Plot No. 2 was heavily thinned, some 40 per cent. of the total number of stems being cut out The girths of all the trees on each plot were then measured in inch-classes and recorded by me. The trees had already attained an average length of clear bole of 30 feet, so what was obviously needed was a thinning with a view to obtain a more rapid girth increment.

After the lapse of five years the girths of the trees in each plot have again been measured and recorded by me and as concrete proof of the beneficial effect of the thinning a comparison of the figures is, I think, of general interest.

An analysis of the measurements shows the following figures :—

	Sample Plot 1.	Sample Plot 2.
Average girth of all trees 6" and over in girth in 1918	18·54 inches.	19·12 inches.
Average girth of all trees 6" and over in girth in 1913	15·81 "	15·63 "
Total annual girth increment per tree in five years	2·73 "	3·49 "
Mean annual girth increment per tree ...	·55 "	·70 "

The thinned sample plot, therefore, shows an increase in mean annual girth increment per tree of ·15 of an inch, which, though it may appear small, would, if maintained for the next 80 years, be equivalent to a girth increment of 1 foot for each tree. With subsequent thinnings, when indicated, this increment I consider should be more than maintained

A comparison of the mean annual girth increment of all the trees in a thinned and an unthinned plot in a young plantation is apt to be misleading, as most of the trees are not likely to become either yield or intermediate yield trees. A comparison of the trees of bigger girth, *viz.*, those likely to include intermediate or final yield trees should, therefore, be considered. Inspection at the time of recounting the two plots in 1918 showed that very few trees below 2 feet in girth were dominant.

Comparing trees of 2 feet and over in girth the figures for the two plots are as follows :—

	Plot 1.		Plot 2.	
	No. of trees.	Aggregate girth in inches.	No. of trees.	Aggregate girth in inches.
1918 ...	97	2,761	100	2,845
1913 ...	47	1,195	39	1,007
Increase ...	50	1,566	61	1,838

In the thinned plot, therefore, 11 trees more than in the unthinned plot have reached a girth of 2 feet or over, and in the thinned plot there is an excess of aggregate girth of 272 inches. In other words, the thinned plot which had an aggregate girth of 188 inches less than the unthinned plot in 1913 has now in 1918 an excess of 84 inches. The thinning was done with the idea of a repetition in five years' time but was necessarily heavy (40 per cent.) as it was long overdue. A second thinning consisting of the removal of 10 per cent. of the trees left was done after the girth measurements had been recorded and in 1923 results should prove even more marked.

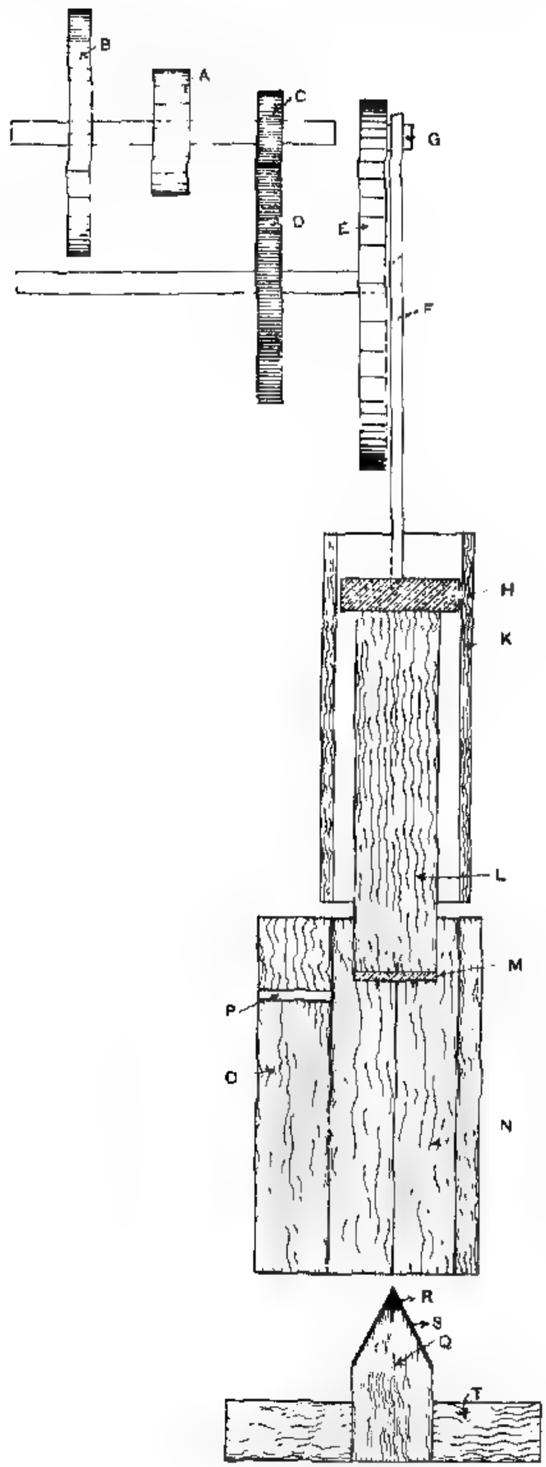
A USEFUL WOOD-SPLITTING MACHINE.

BY J. W. BRADLEY, I.F.S.

The following description of a simple but very effective contrivance for splitting wood billets has been obtained by the courtesy of the inventor, Mr. J. A. Boog of Bassein, Burma.

War conditions and the consequent difficulty in obtaining coal supplies has led to a great increase in the demand for wood fuel. The Irrawaddy Flotilla Co., Ltd., and the Burma Railways are, perhaps, the biggest consumers and they draw their supplies very largely from the Delta forests to the West of Rangoon. It is

SKETCH PLAN OF WOOD-SPLITTING MACHINE.



in the supply of split billets to the former concern that the splitting machine here described has proved its great value. Of the species extracted locally and brought to Bassein for fuel, the best and most plentiful is the "pinlè kanazo" *(Heritiera minor)*. But the great difficulty in splitting this wood by hand has proved a very knotty problem and has incidentally been responsible for great waste of wood too big to be used without splitting. Mr. Boog's device has quite solved the splitting problem and has, in this particular locality, greatly reduced the waste. The machine can readily deal with anything up to 3 feet in girth and will split such knotty pieces as would never be undertaken by hand. Formerly Mr. Boog experienced considerable difficulty in turning out the amount of split fuel required. But now with his machine and four men to feed it, and one man to run the engine, the labour of splitting the fuel has become a comparatively trifling matter. About 30 stacks (stack = 120 stacked cub. ft.) can be handled in a day.

The accompanying rough sketch plan (Plate 6) may suffice to demonstrate the device :—

A takes the belt from the engine.

B is the fly-wheel.

C a small cog-wheel working on D and reducing the speed of B which carries an eccentric at G.

F is the shaft working on the eccentric G and attached to H.

H moves backwards and forwards horizontally in its bed K.

To H is attached L a solid piece of wood faced with a spiked steel plate at M.

L moves backwards and forwards horizontally (in conjunction with H) in a V-shaped trough N.

O is the feeding platform from which the billets are dropped into the trough N. On the platform is a small vertical projection P, against which the billets are placed so as to insure that they shall fall into the trough immediately in front of L.

Q is a wedge shaped wooden projection strongly buttressed at T and fitted with a hard steel blade at R. The faces of Q are faced with metal to project them against wear.

When the machine is in motion L moves slowly backwards and forwards in its trough N to within 3 or 4 inches of the blade R. Billets are dropped into the trough from the platform O when L has receded to its maximum from R. As L moves forwards the billet in the trough is driven against the blade R, on either side of which the resultant splits fall. Large billets that need splitting more than once are split in half and the halves then put in separately and split again.

The rate at which work proceeds depends largely on the experience of the hands feeding the billets. But if the engine is run so that L completes its course to and fro once in about 4 seconds, it is found that experienced men can feed the machine so that a billet is split at every forward motion. If the feeders are not experienced men, failures to feed at every stroke will be more frequent. But inexperience causes nothing more serious than a slight decrease in the outturn.

In the construction of the machine originally some difficulty was experienced in obtaining a large cogged wheel (D) sufficiently strong. The initial shock which occurs on impact of the billet with the splitting blade occasionally caused breakage of the gear teeth. A superior quality wheel is now being used and with satisfactory results. Still the shock to the machine generally is fairly severe and could be greatly reduced if a very strong spring were inserted in the, at present, rigid buffer L immediately behind its steel face.

The machine described above is used for splitting 3 feet billets only and the length of the stroke of the shaft F is fixed accordingly. For splitting shorter lengths this stroke would have to be altered. It could be done by bringing G (the point of attachment of the shaft to the eccentric) closer to the centre of the eccentric E. That is, if G were made movable radially it could be adjusted so as to give a stroke of any required length according to the length of the billets to be split.

It only remains to be remarked that the machine is invaluable in the work for which it is made. It is both simple and efficient; and it could hardly be subjected to a test more severe than the task of splitting so tough a wood as "pinlè kanazo."

FLYING-SQUIRRELS AND PINE CONES.

BY R. S. THOUP, I.F.S.

In his *Note on Some Chir Seed-eaters* in the *Indian Forester* of October last Mr. A. E. Osmaston alludes to the damage done to pine cones by flying-squirrels. I am able to supply the ocular evidence which he considers to be still necessary to prove absolutely his contention that these animals are the cause of the damage described by him and clearly shown in Plate 31. My observations refer to the blue pine (*Pinus excelsa*). In May 1916 I was attracted one night at about 10 o'clock by the noise of cone-scales falling on the roof of an outhouse from a small blue pine tree growing close outside one of the windows of my house in Simla. With the aid of an electric lamp suddenly flashed into the tree I saw clearly, not many feet away, a flying-squirrel hard at work gnawing the young green tender cones, which were then about 4 inches long. The animal was not alarmed, but after staring at the light moved slowly away. The tree was visited for four successive nights, and during this time all the cones on the tree, about 120 in number, were destroyed: the young seed was apparently the part sought for since the scales and axes of the cones were discarded. Although only one squirrel was observed there may possibly have been more; at all events, the destruction of 30 cones a night even by a colony of squirrels for, say, five months from May to September would mean a loss in one season of nearly 4,600 cones, or at a moderate estimate some 500,000 seeds. As far as I could make out, the animal in question was the smaller flying-squirrel (*Sciuropterus fimbriatus*, Gray ?).

THE USE OF ATLAS PRESERVATIVE TO KILL TREES.

BY A. J. S BUTTERWICK, P.F.S.

In the *Indian Forester* for January 1918, Mr. C. W Allan, Extra Deputy Conservator of Forests (retired), wrote about the excellence of the use of Atlas Preservative to kill "trees of all kinds." The Burma Forest School was about to remove some of the overhead cover in a "Y" Improvement felling plot at Ainggyè, 8½ miles from Pyinmana, and it was considered a good opportunity to try the effect of the recommended toxin.

The following trees were treated with the poison on the specified dates : –

Serial No.	Vernacular Name.	Botanical Name.	Girth. ft.	Girth. in.	Date of poisoning	How treated	Remarks.
1	Yinzat ...	*Dalbergia fusca*	5	10	15th July 1918.	Deep girdled	The antiseptic was painted on all over the severed area.
2	Do. ...	Do. ...	9	3	...	...	
3	Dida ...	*Bombax insigne*	4	3	...	...	
4	Zaungpalè ...	*Lagerstrœmia parviflora.*	5	9	...	...	
5	Yon ...	*Anogeissus acuminata*	7	0	...	...	
6	Binga ...	*Stephegyne diversifolia.*	5	1	...	..	
7	Yon ...	*Anogeissus acuminata.*	5	8	...	...	
8	Binga ...	*Stephegyne diversifolia.*	4	1	...	.	
9	Thandè ...	*Stereospermum neuranthum.*	6	1	...	..	
10	Yinzat ...	*Dalbergia fusca*	6	10	...	...	
11	Letpan ...	*Bombax malabaricum.*	8	11	..	...	
12	Byu ...	*Dillenia pulcherrima.*	3	9	28th July 1918.	...	
13	Kathit ...	*Erythrina indica*	2	10	..	...	

Serial No.	Vernacular Name.	Botanical Name.	Girth. ft.	Girth. in.	Date of poisoning.	How treated.	Remarks.
14	Myaukchaw ...	*Homalium tomentosum.*	7	5	22nd July 1918.		These six trees were done strictly in accordance with Mr. Allan's directions.
15	Nyaung round teak.	*Ficus spp.* ...	2	4	...	...	
16	Yon ...	*Anogeissus acuminata.*	4	3	...	Ringed down to the bast only.	
17	Gwe ...	*Spondias mangifera.*	6	0	...		
18	Binga ...	*Stephegyne diversifolia.*	4	10	...		
19	Letpan ...	*Bombax malabaricum.*	5	4	...		
20	Thitpagan ...	*Millettia Brandisii*	4	0	18th July 1918.	Very deeply girdled.	"

It will be noted that only those trees having either very little or no heart-wood at all were selected for the experiment, as these are very difficult, and sometimes impossible to kill by one girdling. Also both hard and soft-wooded species were chosen.

The forest, in which these experiments were done, was of the ordinary moist teak type with a clayey loam. The girdling and painting were done by the students themselves under the immediate supervision of U Tha Myaing, Extra-Assistant Conservator of Forests and Vernacular Instructor, and myself; and Messrs. Clifford and Craddock, the Director and Senior Instructor, respectively, have seen the trees and results. The antiseptic was used in its pure state.

On the 28th July 1918 the trees were examined with the following results :—

No. 5 had some leaves yellow and some of them had already fallen off.

No. 6 had one small side branch, lowest to the ground, withered.

No. 20 had just begun shedding its leaves

All the other trees showed absolutely no signs of any change On the 10th August 1918, the day I left Ainggyè, the trees were re-examined *with the following results* :—

> Nos. 1 to 11 had to be felled as they showed absolutely no signs of dying The Yon No. 5 had, it is true, shed a lot of leaves, but there was a good crop of healthy green ones still remaining on it.
>
> Nos. 13 and 20 were *entirely leafless, No. 14 had lost* a small part of its leaf canopy.

All the other trees showed absolutely no perceptible signs of any change.

The above results do not seem to agree with those arrived at by Mr. C. W. *Allan. It is very probable that we may have done* the trees at the wrong time and in the wrong way, and if so, we stand to be corrected.

When doing the above trials, I tried killing some trees by injecting the pure Atlas preservative into them. The following species were tried :—Letpan, Kathit, Yon, Myaukchaw, Yinzat, Nyaung and Byu. The injection seemed to have a very marked effect on Letpan, Kathit and Myaukchaw, but no appreciable change was noticed in the others. A very curious phenomenon was seen in some of the Letpan and Kathit, as the leaves of some branches withered and fell off, whereas the others (in one case only a small low side branch) remained perfectly green and healthy. It appeared as if I had not bored enough holes, and diffused the poison all round the stem. With a view to further enquiry in the matter, the following experiment was tried by me. There are two large mango trees growing in the School Nursery with the following girths : (*a*) 7′ 9″, (*b*) 7′ 1″. These two trees had been girdled on the 22nd June 1918, and their girdles had been painted over, in the presence of Mr. J. D. Clifford, the Director, with a 10 per cent. solution of the Atlas preservative. This treatment had absolutely no apparent effect on them. *On the 24th August 1918,* into tree No. (*a*) by means of a brace and bit were made seven holes, equidistant from one another. Each hole was ½″ in diameter, 4″ deep, and slanting downwards. Into each was injected with an ordinary glass syringe

50 per cent. solution of Atlas preservative. Tree No. (*b*) was regirdled and the girdle was repainted over with a pure solution of the antiseptic. Both trees were examined a week later; roughly half the leaves on the injected tree had turned brown and were falling off, but there was no visible effect on the girdled one. Two weeks later they were re-examined; almost all the leaves in the former tree had withered but yet there was no effect seen on the latter.

Whilst not claiming in the least that this method of injection is either original or infallible, it seems that it may perhaps be found preferable to the girdling one, as it is as quickly done and is cheaper. Careful research should, however, be made before coming to any definite conclusion in the matter. The great thing is to thoroughly diffuse the poison as it has been found that it is not done, only part of the tree is affected. As a tentative measure, I suggest that for each foot or part of a foot in the girth of the tree (taken at the circle of injection) there should be at least one hole, ½" diameter and 4" deep. Also a 25 per cent. (and perhaps less) solution of Atlas preservative will suffice. In this connection it may be noted that the Director, Mr. J D. Clifford, painted over the stump of a young vigorous teak tree coppiced in our School Nursery with a 10 per cent. solution of the Atlas preservative, and it has not sent up a single coppice shoot, whereas other stumps in the neighbourhood have done so in great numbers.

RUBBER AND THE PORT OF MARSEILLES.

The Administrative Council of the Colonial Institute of Marseilles have just decided, following on an enquiry carried out by its General Secretary, to urge the establishment of an organization which is wanted in Marseilles for the reception, storage and classification of Rubbers which arrive in this port as well as for the creation of a Technical Service for the study of Rubbers with a view to their commercial valuation.

This Technical Service would be established on the lines laid down by Mr. Van Polt, one of the most competent experts in

rubber, in a Report which the Administrative Council of the Colonial Institute has also accepted in its resolutions.

The financial measures strongly recommended by Mr. Alcan to the Professional Syndicate for dealing with Rubbers, with a view to facilitate transactions in these products, have finally been considered by the Administratve Council of the Colonial Institute, which has decided to adopt them in so far as they concern the port of Marseilles.

NEW YEAR'S HONOURS' LIST.

We are glad to see that the following members of the Forest Department figure in the recent *Honours' List* :—

COMPANION OF THE INDIAN EMPIRE.

Charles Gilbert Rogers, Esquire, Chief Conservator of Forests, Burma.

Thomas Reed Davy Bell, Esquire, Chief Conservator of Forests, Bombay.

Walter Francis Perree, Esquire, Conservator of Forests, Kumaon, United Provinces.

Bertram Beresford Osmaston, Esquire, President, Forest Research Institute and College, Dehra Dun, United Provinces.

OFFICERS OF THE BRITISH EMPIRE.

The Honourable James W. Best, Deputy Conservator of Forests, Hoshangabad, Central Provinces.

Alexander Rodger, Esquire, Imperial Forest Service, Burma (Indian Munitions Board).

MEMBER OF THE BRITISH EMPIRE.

Joseph Veasy Collier, Esquire, Deputy Conservator of Forests, Haldwani, United Provinces.

KHAN SAHIB.

Nazir Abbas, Esquire, Extra Assistant Conservator of Forests, Nimar District, in the Central Provinces.

AHMUDAN GAUNG TAZEIK YA MIN.

Mr. Maung Ba, Forest Ranger, in Burma.

EXTRACTS.

AFFORESTATION IN THE UNITED PROVINCES.

BY E. BENSKIN, DEPUTY CONSERVATOR OF FORESTS, AFFORESTATION DIVISION, EASTERN CIRCLE, UNITED PROVINCES.

The sources of wealth and commercial development in these provinces are agriculture and forests, but very few people realize how dependent the former is on the latter. The general public has an idea that the jungles are places to avoid owing to the dangerous wild animals and fevers which they harbour. This paper is, therefore, intended to convert those persons to realize the physical and economic importance of the forests for the prosperity of the country.

PHYSICAL IMPORTANCE OF FORESTS.

A new country is invariably covered with dense forests, which are gradually cleared away by the first settlers to make room for agriculture and to improve the general salubrity of their surroundings. This process has continued through centuries with the development of almost every country, and the forests gradually have receded to those regions topographically unfit for agriculture, and even here they have often been destroyed by physical causes consequent on the wholesale clearance of forests elsewhere. Forests

are Nature's means of dealing with the meteorological forces. It is believed that all rain clouds are derived from the sea and are driven over the continent, where they deposit their mositure, becoming poorer in moisture content the further they travel inland, until they reach a point where they become exhausted. A forest air and soil is always far damper than outside, and the continuous transpiration of a forest creates a wet halo which serves to enrich the winds with moisture and enables them to precipitate further inland. The geographical position of forests is, therefore, of great importance.

Forests by means of their foliage, root system, and litter serve as a protection to the earth against erosion and the rapid run-off of water from the soil. In this way the rain-water has time to soak into the substratum to enrich the springs and is a source of perenninal water-supply to the rivers of the country. Forests are consequently of great physical importance on mountains and hills in checking the rapid wastage of water and for the prevention of floods causing the erosion of the country further downstream.

ECONOMIC IMPORTANCE OF FORESTS.

With regard to the economic importance of forests, this is appreciated to a great extent. The forests, excluding artificial groves of which there are considerable numbers, form, however, only about 8 per cent. of the whole area of the province against an estimated 20 per cent. considered necessary in more advanced countries for the industrial and domestic requirements of the country. The exceptionally high price of timber and the distance of the forests from the industrial centres are serious obstacles in the way of industrial progress in this country. The great war now raging has awakened the Empire to the national importance of the forests and forest conservancy. In Germany you will often see the forests stretching right into the industrial cities and providing the industries with raw material at their doors: these ndustries are so varied that it was estimated that before the war 3,000,000 persons depended on the forests, in some way or other, for their livelihood. It is scarcely necessary to remind the reader of the very large potentialities of the forests of these provinces which are

capable of supplying most of the commodities previously obtained from foreign sources. During the last two years the surplus revenue has been more than doubled as a result of the development of indigenous supply.

EFFECT OF DISFORESTMENT.

Having briefly outlined the physical and economic importance of forests to these provinces, we will go back to the changes effected by unregulated forest clearances in different parts of the world and in these provinces.

We know that the sands of the Sahara and Arabia now cover what was once a fertile land and that many countries, such as Greece, Tripoli, and Palestine, are now only able to support a fraction of their previous populations. We hear from the ancient historians of the intense cold of Greece, then densely wooded, and the perpetual spring of Babylon. The Babylonian tablets of great antiquity refer to the attempts to reclaim the country thrown out of cultivation by the sinking of the spring level and erosion, but these were of temporary benefit. The floods from the mountains increased year by year, the beds of the rivers were scoured out, and irrigation eventually became impossible, for, as with canals so with rivers, the flow is regulated by control at the head-waters. All these countries are now more or less desert and it will be interesting to see how far the effect of forest clearances has been felt in the United Provinces. It is proposed, however, to deal with the country washed by the Jumna river.

THE JUMNA VALLEY.

The Jumna takes its rise in latitude 31° 2′, longitude 70° 27′ about 5 miles north of Jumnotri and 8 miles west of Bundarpunch peak in the Himalayas. Its length from source to confluence with the Ganges is 860 miles. It has 17 tributaries of which 5 rise in the Himalayas, 3 in the Siwaliks, 3 in the Vindhya Hills, 1 in the Satpura Hills, and 5 in the plains of the Doab. If the reader will pick up a map showing the distribution of forests in relation to these rivers, he will see how insufficient is the regulating belt of

forest to control the head waters and in many cases this is absent altogether. In addition to this insufficiency many of the forests are open to grazing and browsing of cattle, resulting in the protective covering of grass being cleared off the ground and the young forest seedlings are eaten down or die through having no depth of soil : in this way the forests eventually become exhausted and disappear. Anybody who has visited the Dehra Dun and Saharanpur districts cannot fail to be impressed with the enormous damage done by sudden floods from the Himalayas and Siwaliks, and it is not surprising to find that the area under cultivation in many villages of the Saharanpur Terai has decreased during the last 50 years. The submontane rivers have been continually changing their courses ever since the hills came into existence causing the land to be covered with a deep boulder deposit. If grazing were entirely excluded the old beds would very quickly become covered over with a dense Shisham (*Dalbergia Sissoo*) and Khair (*Acacia Catechu*) forest which forms very efficient natural training and obstruction works against the force of the floods. Unfortunately a large portion of these forests are open to grazing and the young seedlings are browsed down every year, the beds have widened and the force of the floods has increased. The vegetation on the neighbouring hills is of a very poor description after centuries of abuse and, owing to much of the soil having been carried off, the water flows away with great rapidity, thereby increasing the volume of the torrents and leaving the beds dry a few hours after a storm. Irrigation works have been destroyed by these sudden floods and they are a source of anxiety to the engineer. A similar state of affairs can be found on almost every hill tributary of the Jumna.

The accumulated effect of this flooding and scouring has resulted in the bed of the Jumna at Etawah being lowered 60 feet in the last 500 years and a corresponding sinking of the spring level. The cold weather level of the river in the Etawah and Jalaun districts is often 120—200 feet below the general level of the surrounding country. The sinking of the bed of the river is draining the country, and the well water-levels are sometimes as low as 200 feet. The banks of the Jumna in the Agra, Etawah,

and Jalaun districts are now so completely drained that they have become almost destitute of vegetation except a desert flora, and even this is disappearing. This dry belt is increasing at the rate of 250 acres each year in the Etawah district alone. The absence of protective vegetation on the banks and the flow of water from the high plateau to the river has caused a complicated net-work of ravines to be formed. These ravines often start suddenly at the edge of cultivation with a drop of some 80 feet or they may be less severe, and they take up a meandering course, joining up with other systems, eventually falling into the river. The actual area of these ravines in the Etawah district alone is 120,000 acres and the area of similar land in the provinces is some millions of acres The land is at present almost valueless to the owners as it yields grazing of the very poorest description. Cultivation beyond this desert belt is precarious even in years of almost normal rainfall, and drinking water often becomes so rare as to necessitate the migration of whole villages, and throughout the whole expanse of the ravines there is no water to be found except in the main rivers. A study of the soil will show that it is very fertile, but it is too cut up and arid for cultivation. The monsoon rains only sink to a depth of seven inches, and below this the soil is quite dry till the spring level is struck. It would appear that the present tree growth is of very great age which has continued to reproduce itself by coppice shoots and the root system has kept pace with the sinking spring level; natural reproduction invariably dies down as soon as the rains cease.

The drying up of the country is a most serious matter which may be temporarily relieved by the expenditure of lakhs of rupees on irrigation, but, if the erosion of the country continues at the present rate, irrigation projects will be hampered and eventually become impossible. The Etawah District was once covered with Sal (*Shorea robusta*) forests and many villages are named after the tree—Sakhi Sakrauli, Sakhua, Sakhopur—and it is recorded that the Emperor Babar hunted in these forests. The *Sal* tree requires a moist climate, but the conditions have so changed that there is not a single tree between the Himalayan Terai and the Satpuras. The

drop in the Jumna level is established by the prevalence of old sugar mills in the Etawah trans-Jumna area where the water-level is now far too low to admit of irrigation, and also in the fort at Shergadh near Auraya the curb of the large well in use in 1550 is now 60 feet above mean flood level.

Ravine Reclamation.

The question of utilizing these waste lands in the Agra, Etawah, and adjoining districts for fuel and fodder reserves has often been the subject of investigation by Government. The earliest report on record is that of Dr. D. Brandis, then Inspector-General of Forests to the Government of India. The measures recommended in this report for the encouragement of forest growth were—(1) fire-protection, (2) restriction of grazing, (3) protection from all wood cutting, (4) filling up of blanks by planting and sowing. Enquiries were shortly afterwards made as to the areas of waste lands which could be utilized as fuel and fodder reserves, but action was deferred on the ground of the enormous expense involved. However, in 1882 Mr. J. E. Fisher, Collector of Etawah, called together the zamindars who owned the tract of ravine land to the west of the town of Etawah, and these owners agreed to hand over their land for the creation of a fuel and fodder reserve for the protection of the ground from erosion and further deterioration. The owners of the land were to provide the necessary funds, and in return the profits were to be divided *pro rata* according to the money furnished and the land held in each case. The management of the reserve was entrusted to the Collector, who placed the area under working in the same year. Grazing was prohibited, the soil broken with the country plough, and the seed of babul (*Acacia arabica*), *shisham*, and neem (*Melia indica*) sown. In order to dam up the rain-water and locally raise the spring level, *bandhs* (embankments) were thrown across the ravines in suitable places. It appears from the scanty information available that the small expenditure incurred was more than recouped by the sale of grass and subsequently by grazing dues and light fellings. The scheme worked well for

a time, and there was eventually a fairly good crop of *babul* sufficiently dense and valuable to encourage a firm to take over the forest for the tan bark on a lease of 50 years on payment of approximately Rs. 2 and an annual rental of Re. 1 per acre.

Again in 1901 a small area of ravine land was acquired close to the town of Kalpi, Jalaun district, for the supply of *babul* bark to the Cawnpore tanneries.

EXPERIMENTS IN ETAWAH.

In 1912 the Local Government having defined its policy with regard to the reafforestation of denuded areas and the establishment of fuel and fodder reserves, a preliminary survey was made of existing waste lands, and a report was submitted recommending, in the first instance, the reclamation and utilization of the ravines along the Jumna and Chambal rivers in the Etawah district. The owners of the land were approached and a scheme, somewhat on the lines already referred to in connection with the Fisher forest, was agreed upon, but in this case Government undertook to pay the cost of afforestation and to recoup the expenditure out of the revenue, eventually handing back the lands when the debts had been cleared. In this way the area taken over for reclamation up to date is 22,000 acres and additional land has been promised. The first two years of operations have been of an experimental nature and they have beyond doubt proved the possibility of reclaiming and utilizing these lands as fuel and fodder reserves. There is also every prospect of raising small timber. That plantations successfully raised would be of great economic importance is certain, the high price and scarcity of building timber is well known, there is an ever-increasing demand for firewood, and the demand for tan stuffs is almost unlimited. Local industries are sure to spring up and will add to the prosperity of the district.

The soil of the ravines is of alluvial type, differing only in texture from place to place. This class of soil require constant cultivation, as, owing to its fineness, natural aeration is obstructed, and, on drying, the soil solidifies to the consistency of rock. The re-establishment of sufficiently favourable conditions for vegetation

is the preliminary object ; this can only be done by improving the soil aeration and moisture content and can be at once effected by breaking up the compact surface soil and so aiding the gaseous exchange between the soil and air. This operation also assists the penetration of moisture into the substratum. It is a so necessary to preserve the continuous gaseous interchange between the soil and atmosphere and to prevent further consolidation. Irrigation is, of course, impossible owing to the ruggedness of the ground. Soil cultivation, extended over several years, is impracticable in a forest estate owing to the comparatively low final returns, and could only be carried out for two years at the most, even if only valuable tree species were raised. It is considered, however, that if once a forest can be established the roots will penetrate in all directions into the subsoil and will break it up sufficiently to allow of aeration and moisture soakage. The shade of the trees will, doubtless, prevent excessive consolidation, the litter and grass growth will retard the present rain wastage, and the water which escapes can be caught in small ponds held up by *bandhs* thrown across the ravines, or by blind ditches and embankments on the higher ground. It is also very important that cattle should be kept out of the plantations until they are established as, besides browsing, the tread of cattle hardens the crust of the soil and destroys all the effect of cultivation. For breaking up the soil no better instrument can be found than the Sabul plough, but owing to the roughness of the ground a great deal of work has to be done by hand. The Changa Manga plantations, near Lahore which form, perhaps, one of the finest afforestation achievement in the world, exist entirely by irrigation, whereas in Etawah where irrigation is not feasible, the plantations depend solely upon intense initial cultivation. It is not possible at present to say which system will produce the greatest net return, but the Etawah plantations are no doubt hardier and less liable to insect and fungoidal attacks.

The first noticeable effect of breaking up the soil and conserving the water is the disappearance of the original worthless grasses and their replacement by those of good feeding value. The water wastage is further checked by the heavy grass growth and the beds of the

nalas (ravines) become covered with turf. Sowings of various forest trees have been made on the freshly broken up lands, and it is found that many valuable species can be raised, among which may be mentioned teak, *shisham*, kamhar (*Gmelina arborea*), and *babul*. The success of these sowings during the last two years has been very satisfactory, and in many places the growth is so dense that it is almost impossible to walk through it; many of the trees sown in 1915 are more than 20 feet in height and are already fit for fuel.

An examination of the conditions after these operations shows that the moisture penetration has very materially improved and that erosion has been effectively arrested : it is, however, essential that a broad protective belt of land at the head of the ravines should be afforested to prevent further encroachment inland. Some portions of the areas, less liable to erosion, will be reclaimed as grazing grounds and will be maintained by periodic cultivation. The improvement of village grazing grounds throughout the province by working them on an interchangeable rotation is a matter which deserves the attention of the country so as to relieve the forest of grazing. Up to March 1917, 1,325 acres of ravines had been reclaimed and afforested at a cost of Rs. 78,368, or appoximately Rs. 60 per acre, inclusive of all charges. There is every indication that the cost can be considerably reduced, and that the ravines can be profitably utilized for fuel and fodder reserves. The plantations require very great attention and care during the first few years as they are subject to the attacks of all kinds of enemies.

The reclamation of ravines is a work suitable for famine labour as the work can be closed down at any time without leaving it incomplete and the extension of fodder reserves will be a valuable asset in time of scarcity.

The reclamation of ravines is, in the writer's opinion, however, somewhat similar to curing the pain without eradicating the main cause of the malady. The cause can be traced to the forest denudation at the distant head-waters of the rivers, and it is important that it should be also dealt with there. Much has been done during the past few years to preserve and extend the existing forests in

the Himalayas, but much still remains to be done or we may expect the fate of Babylon. Champollion in referring to the deserts of Northern Africa wrote: "Does any crime against Nature draw down a more dreadful curse than that of stripping Mother Earth of her sylvan covering?"—[*Reprinted from Agricultural Journal of India, Vol. XIII, Part IV, October 1918.*]

THE FORESTRY MUSEUM, RANGOON.

A Very Interesting Exhibition

The want of a provincial museum in Burma has been long felt, and while the war may have had something to do with one not being in existence at the present moment, the forest department of Burma has endeavoured to get together and keep on exhibition an exhibit of most of the major products of their department and the various minor products that are brought to, or come to, their notice. Particularly so is this in respect of the splendid woods of all parts of Burma. It will be remembered that the forest department had a very fine exhibit at the Arts and Crafts Exhibition held during the Viceroy's visit at the Jubilee Hall, and not wishing to let all their time and trouble in getting it together go to waste, the council chamber of the Agri-Horticultural Society in their gardens at Kandawgalay was secured and the exhibit placed there and from time to time augmented. Of course this is only a temporary museum as the accommodation is limited with no room for expansion, but the exhibits are so interesting that it has been decided to open the place to the general public between 7 A.M. and 11 A.M. and 2 P.M. and 6 P.M. daily at the very small fee of one anna. Monday was the opening day, but the attendance was not very large. It is hoped by the forest department to have a much larger place when the provincial museum is started, as part of it. The present exhibition in the forestry museum is designed from an economic point of view, the main point being to bring to public notice what can be obtained from the forests of Burma, what is available for supplying to the public at large and in what quantities and under what conditions.

The main display in the museum is of the most important of the many fine woods that grow and are procurable in Burma and in getting the exhibit together the forest department have selected a very representative collection. There are, however, very many more woods than are shown in the museum and these the department hopes to get together when more space to exhibit them is at their disposal. Many of these exhibits of wood are in logs, or in sections, and are so cut and polished as to show the grain of the wood and give an idea of the purpose for which they can be used and in what different forms of manufactured articles they would be most useful. The sections which are cut have been in many instances highly polished and it is surprising how many, in the small space at their disposal, magnificent woods have been got together. An exhaustive article on the original exhibit at the Jubilee Hall appeared in these columns at the time and there are so many of these woods in the museum that a detailed article at the present time is unnecessary There are, however, a number of the more important woods which are not very well known to those using Burma timber and the desire of the forest authorities is to let people know where they can be seen and for what purposes they can be used All information concerning them can be obtained from the forest research officer. Among the more important woods to be seen at the museum are : *Thingan*, a hard, durable wood used a great deal by the Burman in the building of boats ; the Burmese *padauk* which, while not so highly coloured as the Andamans *padauk*, is nevertheless a most durable and useful wood, more so than the Andamans product, and a great deal of it is shipped from Burma to India and elsewhere, where it is employed in the making of gun carriages. It is very hard and very heavy. *Tinyu* or Southern Shan States pine is another of the fine woods to be seen in the museum and it can be used in the making of many articles ; *petwun* is another wood that is plentiful in Upper and Lower Burma It is a very handsome and fairly common wood and can be used in various ways. *Sandawa* is another handsome though little known wood which is found in the Toungoo forests and which, like

other hard and durable woods, can be utilized for many articles that require great wear and strain ; *pyinma*, another well known wood, is found in large quantities and has various uses ; *yindaik*, commonly called the Burmese ebony, on account of its very hard black centre, is a most durable and beautiful product and is utilized in fancy articles, cabinets, etc. ; *kanyin* is a wood that is obtainable in large quantities in the damp forests of Burma and trees of it are to be seen in Wingaba road. It is one o the tallest trees in Burma and one of the straightest and largest and forms a fine wood for many purposes. *Ingyin* is another of the very fine and durable woods of Burma to be seen here and its uses are numerous ; *pyinkado*, or iron wood as it is known, is present in the shape of numerous exhibits ; its uses are too well known to go into detail about them ; several varieties of Andamans woods are also to be seen inside the museum and a wooden cart-wheel used by the Burmese made of one solid piece of *thingan* wood forms an interesting exhibit. This was obtained from Pegu. The cart-wheel referred to used to be cut from a section of the tree and, as soon as sufficient wood for the wheel had been obtained, the rest of the section was allowed to decay. This waste has now been stopped. Continuing with the woods, the visitor can see a plentiful supply of various kinds on the portico surrounding the present museum, there being no room inside for them. Here are large sections of logs and slabs, among which are *ponnyet* which is considered very suitable for the making of ship's masts ; it is a Moulmein wood and is plentiful. *Myauklot* is another fine wood which polishes highly and is adaptable for either the floors of buildings or furniture ; it has also been used for building houses. Another building wood and one utilized where very hard and durable timber is necessary is *thadi* ; logs of Rangoon *padauk* are to be seen and one piece in particular is from one of the trees that died in Rangoon last year when so many of these fine trees died ; *hnaw* is another building wood that is of a fine durable quality that can be seen here and *in* or *eng* as it is more familiarly known can also be seen ; this is considered by forest authorities as one of the most useful woods in the province ; it is also one of the commonest. *Nabe* is

another common wood which is used for all sorts of manufactures; *gyo* is a hard durable wood used in great quantity in the making of cart-wheels, axles, etc.; many other less important woods are also to be seen here.

Returning inside again one sees in nearly every corner piles of the most important bamboos of the province, collected from Bhamo to Tennasserim. To the uneducated timber eye they all look alike but a close scrutiny shows many differences. Skied in alcoves around the building under the eaves are to be seen various kinds of basket work, Burmese drums, hats, and many other indigenous manufactures.

Around the walls are some splendid heads of saing and bison shot or picked up in various parts of the province by forest officers. It is hoped to increase this collection as soon as space is available to hang them Another interesting head is that of the *takin*, an animal of the goat or antelope tribe which was shot in the Htawgaw hills above Myitkyina and was loaned to the museum by Mr. Clerk of the Myitkyina Hill Tracts.

There are numerous interesing photographs on the walls and in various parts of the museum showing forest work in all its phases, particularly interesting being the collection of photographs of the river training scheme at Myitmaka for the extraction of teak timber from the Prome and Tharrawaddy Forests. This work was started and carried out with eminent success by Mr. Leet, Conservator of Forests, now on leave. Close to where these photographs are to be seen are some very interesting specimens of irregularly grown teak from the alluvial soil of Arakan. There is also from Shwegyin a very striking specimen. There is no natural teak in Arakan and these specimens show how very flated and fantastic in shape teak that comes from there is. In close proximity are specimen pieces of the healthy, well matured teak that is being furnished to the British Admiralty and contrast between the two kinds is striking. Some of the best teak is said to come from the Tharrawaddy and Pyinmana Forests.

An interesting display in the museum is a collection of various kinds of woods that have been damaged by the bee-hole borer,

by woodpeckers, by beetles and by white-ants. These show the ravages of these enemies of timber in Burma in no uncertain way and they are well worth seeing. Such hard and durable woods as *pyinkado* and *ingyin* are not safe from their operations. In this collection is quite an unusual exhibit, a very fine specimen of two white-ants' nests in perfect conditions. These are at the bottom of an ordinary almirah taken from a house in Botatoung. With this exhibit is the so-called water elephant or *yezin* in a glass case all by itself. One has only to look at it carefully to see what a consummate fake it is. Alongside it is a piece of hard clay in which is the pug of a tiger very distinctly marked. In various parts of the museum are the botanical specimens which have been gathered together just to show the method of collection and classification for identification. There are also specimens of seedling trees at various stages of growth. Maps of various forest groups or tracts are to be seen in which, in colours, the predominating woods to be found there are marked off mostly with respect to teak, pyinkado and bamboo. There also specimens of petrified or fossilized wood from the Upper Burma dry zone which is used for various purposes in Pagan and other places. Also to be seen in the museum are pieces of cutch wood and the product obtained from it, cutch boiling being a flourishing trade carried on in Upper Burma and Prome. The disposal of the cutch is for the most part in the hands of Chinese brokers who finance the villagers who boil the cutch. Close by are specimens of the handiwork of a new industry that is springing up in Burma, *i.e.*, the making of boxes for shipments of rubber, candles, cutch, etc.; wooden axles, pick handles, and many other things that used to be imported from other countries. The Upper Burma Wood Company are active in this enterprise. It is a trade that shows great promise and large results are hoped for from it. Lacquer work has always been familiar at the Provincial Arts and Crafts exhibitions, but in the museum are shown pieces of the *thitsi* wood from which resin is obtained and in fact everything from the raw material to the finished product is to be seen with photographs showing how the result is obtained. A tree very much overtapped

obtained from the Southern Shan States, is one of the interesting exhibits in this section. There is also an exhibit showing the raw material and products of the lac industry. In another corner is a glass case in which are to be seen Burmese musical instruments, toys, umbrellas, walkingsticks, etc., made from various Burma products. In the centre of the museum is an interesting exhibition in a glass almirah. Here are shown various kinds of fibres, tanning materials, resins from various trees, and miscellaneous fruits, food oils, and seeds. Among the oils is the *Chàulmugra* made from the Kalaw fruit which is used in India as a cure for leprosy. Distilled camphor is also to be seen. This was obtained from Formosa camphor trees growing in the Southern Shan States. These trees are said to be thriving there. Further along is an exhibit showing various kinds of paper made from bamboo, *kaing* or elephant grass and paper mulberry. These are the samples and show what can be done with Burma raw material. It is believed that Burma paper pulp has a great future. There is also a display of the raw and finished material from which match boxes and the match sticks of Burma matches, of the Burma Match Factory (Messrs. Lim Soo Hean and Company), and the Irrawaddy Match Factory of Mandalay, are made. Not uninteresting are pieces of wood and bamboo which have been given to the museum by the Burma Mines Company at Namtu which, it is stated, have been taken from the old galleries of the mines worked by the Chinese hundreds of years ago. Their state of preservation is really remarkable. There are many other interesting things to be seen here and one can spend an hour and a half easily by casually going from exhibit to exhibit. On the table in the museum are many books of reference concerning the forests of Burma and their products. The exhibits are compactly but attractively arranged in the museum and are in charge of the Forest Research Officer and the place is well worth a visit by any one who cares to see and learn what can be obtained in Burma from this department of the Government. The museum is on top of the knoll where the flower, fruit and vegetable exhibitions of the Agri-Horticultural Society are usually held.—[*Rangoon Gazette*]

A NEW USE FOR THE GUM OF *BUTEA FRONDOSA*.

Mr. W. A. Davis, Indigo Research Chemist to the Government of India, has just published a brochure entitled "The Loss of Indigo Caused by Bad Settling and the Means of Obviating this: The use of Dhak Gum—*its effect on yield and quality*." One of the principal causes of loss in the **manufacture of indigo** is due to finely divided suspended particles of indigo being carried off with the large volume of seet-water, which is run off after the settling of the indigo when beating is finished. It is calculated that for every pound of indigo obtained about 3,000 pounds of water have to be run off. If the seet-water contains only one part of indigo in 10,000 (*i.e.*, 0·01 per cent.), the loss of indigo is 30 per cent. The remedy against this waste, it is suggested, is the use of **Dhak gum.** From a number of trials made it has been found that the use of Dhak gum has no appreciable effect in lowering the quality of the indigo obtained whilst in most cases it greatly increases the produce—in several instances by 3 to 6 seers of indigo per 100 maunds of plant. What the Dhak gum does is simply to carry down the finely divided indigo which does not readily settle, so that the indigo obtained with the use of Dhak gum is of practically identical quality with that made without its use. It is at factories where the conditions of fermentation are unfavourable or the quality of the plant is poor, so that both yield and quality of the indigo are low, that Dhak gum is said to give the best results. The following particulars are given regarding Dhak gum and the method of using it to improve settling of indigo:—

The Dhak gum is a ruby coloured gum which exudes from the *dhak* tree or *palas* (*Butea frondosa*) and is an article of commerce in the United Provinces. Before the war it sold in Cawnpore at about Rs.7 to Rs.8 a maund, but recently, owing to an increased demand, its price has been somewhat higher and it has been adulterated with bits of bark, frequently, in samples I have examined, to the extent of 30 to 40 per cent. A *good* sample should contain at least 90 per cent. of water-soluble gum; a certain amount of bark (up to 10 per cent.) is accidental as, in picking, the

bark cannot be entirely removed. But such a proportion of bark as 20 to 30 per cent. means deliberate adulteration. In actual working, Dhak gum is used in the proportion of 1 seer of gum per 100 maunds of plant. Each seer is soaked in a bucket of water overnight to soften it and the water then raised to the boil to dissolve the gum. The liquor is strained through a cloth and sprinkled on the surface of the beating vat about 5 minutes before beating is ended. The action of the beating wheel is then continued for 5 to 10 minutes to ensure thorough mixing and the mal is then left to settle in the usual way. If the Dhak gum contains much wood (20 to 30 per cent.) it may be desirable sometimes to use slightly more gum (up to 1¼ seers per 100 maunds of plant). It can easily be ascertained whether such increase in the quantity of gum increases the produce. Mr. Davis summarizes the results as follows :—The use of Dhak gum throughout mahal to improve settling after beating is strongly recommended. Increases of produce of 3 to 6 seers of cake indigo per 100 maunds of plant have actually been obtained at several factories by the use of Dhak gum. An increase of 6 seers of indigo represents an increase of about 70 per cent. with ordinary Sumatrana working which gives only 8 to 9 seers of indigo per 100 maunds of plant worked, and of about 35 per cent with Jawa plant. (2) Data are given to show that the use of Dhak gum does not cause any appreciable deterioration of quality. The variations in quality in trials made with and without gum are no greater than those which occur in ordinary daily working Sometimes the indigo made with gum is better than that made without it, but sometimes the reverse holds. (3) Of course, when very favourable conditions of fermentation exist at a factory and settling is nearly perfect in consequence, the use of Dhak gum will not give much increase of yield. But *perfect* settling is rare and I would recommend that the Dhak gum be *always* used as part of the factory routine. The cost of the gum is relatively small and in average factory practice the loss of indigo by imperfect settling is considerable. On many days the indigo passing away in the seet-water may easily exceed 1 part in 10,000 (which represents a loss of 30 per cent of the

indigo in Sumatrana plant). When settling is already perfect and the gum does not cause any increase of produce, its use is not harmful as it does not injure the quality of the high grade indigo obtained under such conditions. (4) The Dhak gum is most useful in factories where unfavourable fermentations occur which give rise to the so-called "green vats"; in such cases settling is greatly improved and the indigo obtained filters and presses far more easily.—[*The Indian Trade Journal*]

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THE FOOD PLANTS OF INDIAN FOREST INSECTS.

BY C. F. C. BEESON, M.A., I.F.S., FOREST ZOOLOGIST.

PART I.

The most desirable contribution to the literature of Forest entomology in India is a list of the insect pests of forest trees; data are now available for a preliminary list, but these records form a disconnected series and are incidental to investigations carried out on a few of the principal timber trees.

It appears advisable to publish, as a first step, systematic lists of insects with their food plants in the hope that the appearance of the available information will indicate omissions and lacunæ, and possibly glean additional data from divisional officers and from sources outside the Department.

It is proposed to issue, at regular intervals, annotated lists of insect species of which the food plants are known, with their distribution and feeding habits. The records are for the most part new; (for example, in 1914 Stebbing published 20 species of the family Bostrychidæ, with 45 records of host plants; in the

present note 30 species are listed with 89 records of host plants). Unless otherwise stated, all records are substantiated by specimens or notes at the Research Institute; where a record is given on other authority a reference is made in a foot-note to the literature or unpublished source.

All identifications have been made by specialists in Europe and America or by the writer; numerous records have been omitted for want of authentic determinations.

Where the distribution of a species is well known or has been summarized in a monograph, such information is given in square brackets. New records outside the region thus defined are quoted by forest division and province (*e.g.*, Simla means Simla forest division and not Simla station).

In view of the fact that the food plants of an insect species which is a pest of a forest tree, may comprise plant species which are of neutral importance to forestry, it is considered desirable to include all such records; provided that the food plant is one of the trees, shrubs and climbers mentioned by Gamble in his " Manual of Indian Timbers." The valuable timber species of which a given insect is a pest is not necessarily the principal food plant of the latter.

The arrangement of families and species is alphabetical.

COLEOPTERA.

ANTHRIBIDÆ [PLATYRRHINIDÆ.]

Aræcerus fasciculatus, De Geer.

Seed borer.—*Areca Catechu* [1]; *Papilionaceæ* [2].

Distribution.—[Cosmopolitan.]

Eucorynus crassicornis, F.

Sapwood borer.—*Shorea robusta, Terminalia tomentosa.*

Distribution.—[India ; Burma ; Malaya.]

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[1] Barlow, 1900, p. 125.

[2] Van der Goot, 1917

Litocerus pavlei, Lesne.

Sapwood borer.—*Bombax malabaricum, Shorea robusta.*

Distribution.—[Lower Burma; Arbor]; Siwaliks, Ramnagar, U. P.

Ozotomerus maculosus, Perr.

Sapwood borer.—*Heritiera Fomes, Shorea robusta.*

Distribution.—Sundarbans, Tista, Bengal; Goalpara Assam.

Phlœbius apicalis, Walker.

Sapwood borer.—*Xylia dolabriformis.*

Distribution.—[Ceylon]; Tharrawaddy, Burma.

Physopterus agrestis, Boh.

Sapwood borer.—*Shorea robusta.*

Distribution.—Siwaliks, Gorakhpur, U. P.; Jalpaiguri, Bengal.

Xylinades plagiatus, Jordan.

Sapwood borer.—*Shorea robusta, Xylia dolabriformis.*

Distribution.—[Burma; Assam; Arbor]; Buxa, Bengal.

BOSTRYCHIDÆ.

(The distribution records in square brackets are taken from Lesne's "Revision des Coléoptères de la famille des Bostrychides" in the Annales de la Société Entomologique de France.)

Apate submedia, Walker.

Wood borer.—*Casuarina equisetifolia.*

Distribution.—[Malabar; Ceylon]; Nellore, Madras.

Bostrychopsis parallela, Lesne.

Wood borer.—*Dendrocalamus strictus.*

Distribution.—[India; Burma; Malaya.]

Calopertha truncatula, Ancey.

Wood borer.—*Acacia albida* [1], *Acacia modesta.*

Distribution.—[North Africa; Arabia]; Rawalpindi, Punjab.

[1] Lesne, P. 1906, p. 462.

Dinoderus brevis, Horn.

Wood borer.—*Dendrocalamus strictus, Shorea robusta.*

Distribution.—[India ; Burma ; Malaya.]

Dinoderus distinctus, Lesne.

Wood borer —*Mangifera indica.*

Distribution.—[Philippines] ; Siwaliks, U. P.

Dinoderus minutus, Fabr.

Wood borer —*Dendrocalamus strictus*, "Bamboos."

Distribution.—[Cosmopolitan in tropical regions between the annual isotherms of 18° or 20°.] *

Dinoderus pilifrons, Lesne.

Wood borer.—*Dendrocalamus strictus*, "Bamboos."

Distribution.—[India ; Burma ; Malaya.]

Heterobostrychus æqualis, Waterh.

Wood borer.—*Bombax malabaricum*, "Bamboos," *Dendrocalamus strictus, Odina Wodier, Poinciana elata, Shorea robusta.*

Distribution.—[India ; Burma ; Malaya] ; Simla, Punjab ; Chakrata, U. P. ; Bhutan.

Heterobostrychus hamatipennis, Lesne.

Wood borer.—*Acacia Catechu, Dalbergia Sissoo.*

Distribution.—[India ; Indo-China.]

Heterobostrychus pileatus, Lesne.

Wood borer.—*Shorea robusta.*

Distribution.—[India ; Indo-China.]

Heterobostrychus unicornis, Lesne.

Wood borer.—*Shorea robusta.*

Distribution.—[India ; Indo China.]

Parabostrychus elongatus, Lesne.

Wood borer.—*Mallotus philippinensis, Mangifera indica.*

Distribution.—[Tonkin]; Siwaliks, U. P.

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* Lesne, P. 1897, p. 330.

Phonapate frontalis, Fåhr., **uncinata**, Karsch.

Shoot borer.—*Dendrocalamus strictus.*

Distribution.—[North Africa ; Asia Minor ; Punjab]; Jhansi, U. P. ; Peshawar, N.-W. F.

Schistoceros anobioides, Waterh.

Wood borer.—*Bombax malabaricum, Psidium Guava, Shorea robusta.*

Distribution.—[India ; Burma.]

Schistoceros malayanus, Lesne

Wood borer.—*Heritiera Fomes.*

Distribution.—[Malaya] ; Sundarbans, Bengal.

Sinoxylon anale, Lesne [6].

Wood borer.—*Acacia Catechu, Acacia modesta, Albizzia procera, Anogeissus latifolia, Castanea vesca, Cedrela Toona, Dalbergia latifolia, Dalbergia Sissoo, Dendrocalamus strictus, Eugenia Jambolana, Mangifera indica*[7], *Melia Azedarach*[7], *Prosopis spicigera, Pterocarpus Marsupium, Shorea robusta, Terminalia belerica, Terminalia tomentosa, Xylia dolabriformis.*

Distribution.—[India ; Burma ; Malaya.]

Sinoxylon atratum, Lesne.

Wood borer.—*Acacia Catechu, Anogeissus latifolia.*

Distribution —[Malabar, Kanara, Bombay ; Konoor, Madras] ; Haldwani, U. P.

Sinoxylon atratum, Lesne, **kohlarianum**, Lesne.

Wood borer.—*Mallotus philippinensis, Shorea robusta, Terminalia belerica.*

Distribution.—[Chota Nagpur] ; Siwaliks, U. P.

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[5] Beeson, C. F. C , 1915, pp. 8—11 (*Bostrychopsis* sp.)

[6] The insect described by Stebbing, 1914, p. 150 and fig. 97 as *Xyloperthа* (?) sp. is an immature *Sinoxylon anale*.

[7] Agric. Res. Inst., Pusa, teste ; C F.C.B. *vid.* 1918.

Sinoxylon capillatum, Lesne.

Wood borer.—*Acacia modesta, Albizzia Lebbek, Dalbergia Sissoo, Mallotus philippinensis, Shorea robusta.*

Distribution.—[Kashmir]; Rawalpindi, Lahore, Punjab; Siwaliks, U. P.; Jamalpur, Bihar and Orissa.

Sinoxylon conigerum, Gerstacker.

Wood borer.—*Albizzia amara.*

Distribution.—[East Africa; Ceylon; South India; Java]; Siwaliks, U. P.

Sinoxylon crassum, Lesne.

Wood borer.—*Acacia Catechu, Acacia modesta, Albizzia procera, Anogeissus latifolia, Castanea vesca, Dalbergia Sissoo Mallotus philippinensis, Milletia auriculata, Prosopis spicigera, Pterocarpus Marsupium, Shorea robusta, Terminalia belerica, Terminalia Chebula, Terminalia tomentosa.*

Distribution.—[India; Indo-China.]

Sinoxylon crassum, Lesne, **dekkanense,** Lesne.

Wood borer.—*Acacia Catechu, Albizzia procera, Bombax malabaricum, Pterocarpus Marsupium, Terminalia belerica.*

Distribution.—[Bengal; Chota Nagpur; Madras; Bombay; Travancore]; Central Provinces; Bahraich, U. P.

Sinoxylon dichroum, Lesne.

Wood borer.—*Mallotus philippinensis.*

Distribution.—[Ruby Mines, Burma]; Siwaliks, U. P

Sinoxylon indicum, Lesne.

Wood borer.—*Anogeissus latifolia.*

Distribution.—[Peninsular India; Bengal; Burma.]

Sinoxylon pugnax, Lesne.

Wood borer.—*Acacia modesta.*

Distribution.—[Baluchistan; South India]; Rawalpindi, Punjab.

Sinoxylon pygmæum, Lesne.

Wood borer.—*Mallotus philippinensis, Terminalia belerica.*

Distribution —[Bombay ; Mysore] ; Siwaliks, U. P.

Sinoxylon sudanicum, Lesne.

Seedling-girdler.—*Dalbergia Sissoo.*

Wood borer.—*Albizzia Lebbek, Butea frondosa, Casuarina equisetifolia, Mallotus philippinensis.*

Distribution.—[Sudan ; Peninsular India] ; Rawalpindi, Lahore, Punjab ; Jhansi, Saharanpur, Siwaliks, U. P.

Sinoxylon tignarium, Lesne.

Wood borer.—*Mallotus Roxburghianus.*

Distribution —[China] ; Darjeeling, Bengal.

Xylodectes ornatus, Lesne.

Wood borer.—*Acacia Catechu, Castanea vesca, Dalbergia Sissoo, Shorea robusta, Terminalia belerica.*

Distribution.—[Indo-Malaya.]

Xylopsocus capucinus, Fabr.

Wood borer.—*Mangifera indica*[9].

Distribution —[India ; Burma ; Malaya ; China.]

Xylothrips flavipes, Illiger.

Wood borer.—*Mangifera indica, Shorea robusta, Theobroma Cacao.*

Distribution.—[India ; Burma ; Malaya.]

BRENTHIDÆ.

Ceocephalus cavus, Walk.

Wood borer.—*Terminalia tomentosa.*

Distribution.—[Ceylon] ; Siwaliks, U. P.

Ceocephalus [Hormocerus] reticulatus, Lund.

Wood borer.—*Bombax malabaricum, Castanopsis tribuloides.*

Distribution.—[Java ; Malaya] ; Siwaliks, U. P. ; Jalpaiguri, Bengal.

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[9] Lesne, 1900, p. 634.

Prophthalmus tridentatus, Lund.

Wood borer.—*Pterospermum acerifolium.*

Distribution.—[Indian Archipelago ; Java] ; Darrang, Assam.

BRUCHIDÆ [LARIIDÆ].

Caryoborus [Pachymerus] gonagra, Fabr.

Seed weevil.—*Bauhinia malabarica, Bauhinia racemosa, Cassia auriculata, Cassia Fistula, Cassia montana,*[8] *Casuarina equisetifolia, Hardwickia binata, Prosopis juliflora, Tamarindus indica.*

Distribution.—[India]

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(*To be continued.*)

[8] Stebbing, 1914 (pp. 251, 252 and index p 637) states that this species infests the seeds of *Cassia muritura* (sic) in Cuddapah. As *Cassia montana* is also quoted as one of the host plants, it is presumed that the former record is a MS. error.—C. F. C. B.

CONCENTRIC RINGS IN SANDALWOOD.

BY R. S. TROUP, I.F.S.

Opinions appear to differ as regards the accuracy of ring-countings as a means of determinating the age of sandalwood (*Santalum album*): the following results obtained from the examination of concentric rings on sections of trees cut in plantations of known age in Coorg and Mysore may therefore be of interest.

In May 1917 nine sandalwood sections from plantations of different ages in Coorg were received from the Deputy Conservator of Forests. Countings of the rings were made by Mr. Troup—(1) on a smooth dry surface, (2) on a surface moistened with (*a*) water, (*b*) red ink, and (*c*) black coffee; the results were as follows:—

(1) In no case were the rings all distinct, the number counted falling short of the actual age by several years in each case.

(2) The rings were, as a rule, more distinct in fast-grown than in slow-grown specimens.

(3) Water or coffee unusually rendered the rings more distinct but red ink tended to obscure them.

As these countings in respect of only a few sections from one portion of the sandal zone were considered inadequate, 39 sections of sandalwood cut at a height of 6 inches above ground-level from trees in plantations of known age in Mysore were obtained in March 1918 from the Conservator of Forests, Mysore. These were examined by Mr. Troup, the rings being counted on surfaces which were smooth, slightly rough, dry and wet. The countings were made without any knowledge of the correct age of the sections, the latter being ascertained afterwards from the statement of particulars supplied by the Conservator of Forests The results obtained were as follows:—

(1) In only one case did the number of rings coincide with the correct age of the section; in three cases the rings were so indistinguishable that no attempt could be made to estimate the age; in two cases the number of rings counted exceeded the age of the

section; in the remaining 33 cases the number of rings counted was less than the age of the section, the average discrepancy being 12 years, representing a discrepancy of 32 per cent. on the average age of the 33 sections, which was 37 years.

(2) As a general rule the rings were clearer on the sapwood than on the heartwood and on a wet than on a dry surface; they varied greatly in clearness in different specimens, but in few cases were they clear enough for anything approaching accuracy, and often a recount gave a different figure from the original counting.

(3) Although the specimens were obtained from different localities and types of soil and from trees of varying ages and rates of growth, there was nothing to show that any of these factors had any marked influence on the clearness of the rings.

Not satisfied with his own results, and in order to provide for an independent examination of the Mysore sections, Mr. Troup sent these sections, after completing his own countings, to Mr. Marsden and asked him to examine them. Along with the sections Mr. Troup sent Mr. Marsden the particulars regarding them which were furnished by the Conservator of Forests, but neither the details nor the results of his own countings; Mr. Marsden's results, therefore, have been obtained quite independently of those of Mr. Troup.

The appended statement gives particulars of the sections examined, and particulars of the countings made by Mr. Troup and Mr. Marsden respectively. It will be observed that the figures obtained by these two officers coincide in five cases only, and in none of these is the ascertained age the correct one. The correct age was obtained by Mr. Marsden only in two cases: he states his conclusions as follows:—

"The cross-sections have been smoothed and the rings examined after moistening the surface. By suitable magnification a more accurate comprehension of the rings might be possible, but it would be difficult to draw the line between what is academically possible and what is practically useful. For this reason no lens was used. Magnification in some cases confuses rather than elucidates. The conclusion reached is that on specimens from

vigorous trees a fair estimate of the age is possible, but that on slow-grown trees it is not possible to determine the age from the rings except perhaps in the laboratory and by the aid of stains and microscopes, and even this is doubtful. False rings are not uncommon."

General conclusions.—From the results of these investigations it may be concluded that as a means of obtaining an accurate estimate of the rate of growth of sandal ring-countings under ordinary field conditions cannot be relied on except in occasional individual cases. There is little or no doubt that annual rings are regularly formed; this is evident from the fact that the rings correspond more or less with the known rate of growth over that part of the radius on which they are distinctly visible. False rings, however, are not infrequent, and this, together with the fact that the rings are often indistinguishable, accounts for the uncertain results obtained from ring-countings. There is more likelihood of an approximately accurate result being obtained in the case of fast-grown than of slow-grown specimens, but the tendency in either case is to underestimate the correct age, often by a wide margin.

Statement showing particulars of specimen sections of

Serial No. of specimen.	District.	Name of plantation.	Nature and description of soil.	Recorded year in which plantation was made.	Dimensions of tree from which the section was obtained. Girth at height of 6" from ground-level.		Height.	
					Ft.	in.	Ft.	in.
1	Bangalore...	Nallal ...	Laterite ...	1868-69	2	9	30	0
2	Do. ..	Do. ..	Do. ...	Do. ..	2	4	29	0
3	Do. ...	Appasandra .	Do. ...	1872-73 ...	2	2	27	0
4	Do. ,	Do. ...	Do. ...	Do .	2	0	26	0
5	Do. ...	Gollahalli ...	Do. ...	1884-85 ..	1	9	19	0
6	Do. ...	Do. ...	Do. ...	Do. ...	1	9	22	0
7	Do. ...	Old Jadiganahalli.	Do. ...	1868-69 ...	1	8	21	0
8	Do. ...	Do. ...	Do. ...	Do. ...	1	10	22	0
9	Do. ...	New Jadiganahalli.	Do ...	1886-87 ..	1	6	18	0
10	Do. ...	Do. ...	Do. ...	Do. ...	1	5	20	0
11	Do. ...	Aralemakarhally.	Do. ...	1865-66 ...	1	2	16	0
12	Do. ...	Peenya ...	Red sandy loam	1885-86 ..	1	2	16	0
13	Do. ..	Do. .	Do. ...	Do. ...	1	8	20	0
14	Do. ...	Kodigehalli ..	Do. ..	1887-88...	2	2	26	0
15	Do. ...	Do. ..	Do. ...	Do. ...	1	8	20	0
16	Do. ...	Bettahalli ...	Do. ...	Do. ...	2	0	25	0
17	Do. ...	Do. ...	Do.	Do. ..	1	6	19	0
18	Do. ..	Jarakabandi .	Do. ...	Do. ..	1	6	20	0
19	Do. ..	Do. ...	Do ...	Do. ...	1	5	17	0

Sandalwood from plantations in Mysore.

Age of plantation as recorded.	Countings by Mr. Troup.		Countings by Mr. Marsden.	
	No. of visible rings counted on section.	Remarks on clearness of rings, &c.	No. of visible rings counted on section.	Remarks on clearness of rings, &c.
Years.				
49	43	Rings very indistinct, clearer on wet than on dry surface, clearer on sap-wood than on heart-wood.	35	Rings clear, dark in heart-wood.
49	30	Do. do. ...	26	Rings clear in heart-wood, but very confusing in sap-wood on account of variations in the thickness of the latter.
45	34	Do. Clear on sap-wood. .	26	Rings not clear.
45	34	Do. do.	24	Rings very clear in sap-wood.
33	27	Do do. ...	25	Rings clear, dark-coloured in heart-wood and whitish in sap-wood.
33	33	Rings fairly distinct even on a dry surface.	29	Rings distinct, heart-wood yellowish.
49	31	Rings very indistinct; somewhat clearer on a wet than on a dry surface.	31	*Rings not very distinct.*
49	33	Do. do. ...	37	Do. do.
31	29	Rings fairly distinct ...	28	Rings somewhat clear, but round the edge of heart-wood false rings are numerous.
31	28	Rings fairly distinct except in centre.	26	Rings not very clear.
52	19	Rings fairly distinct. Possibly a mistake in recorded age of plantation.	19	Rings almost distinct.
32	26	Rings *somewhat indistinct*, wavy.	24	Do.
32	20	Rings very indistinct ..	23	Rings not clear.
30	...	Rings indistinguishable except on sap-wood.	26	Rings not clear, very obscure in the heart-wood.
30	25	Rings fairly distinct in parts, but obscure towards centre	25	Rings clear.
30	28	Rings fairly distinct ...	30	Do.
30	15	Rings indistinct on heart-wood	17	Rings obscure in the heart-wood but clear in the sap-wood.
30	27	Rings fairly distinct ...	28	Rings clear.
30	...	Rings indistinguishable ...	17	Rings obscure in the heart-wood, distinct in sap-wood.

Statement showing particulars of specimen sections of

Serial No. of specimen.	District.	Name of plantation.	Nature and description of soil.	Recorded year in which plantation was made.	Dimensions of tree from which the section was obtained. Girth at height of 6" from ground-level.		Height.	
					Ft.	in.	Ft.	in.
20	Bangalore	Jakkur .	Red sandy loam	1865-66 ..	1	10	23	0
21	Do ..	Do. .	Do. ...	Do. ...	1	5	18	0
22	Do. ...	Kadgudi ...	Laterite ...	1868-69 ...	2	0	26	0
23	Do. ...	Do. ...	Do. ...	Do. ...	1	6	20	0
24	Do. ...	Tindal ...	Do. ...	1886-87 ..	1	6	18	0
25	Do. ...	Do. ..	Do. ...	Do. ...	1	6	16	0
26	Do. ...	Tatnur ...	Do. ..	Do. ...	0	10	12	0
27	Do. ...	Do. ...	Do. ...	Do. ...	1	3	16	0
28	Do ...	Nagarbhavi .	Red sandy loam and rocky.	Do. .	1	0	14	0
29	Do. .	Do. ..	Do. ..	Do. ...	0	9	11	0
30	Do. ...	Kenchanahalli	Do. .	Do. ..	1	1	14	0
31	Do. ...	Do ...	Do. ...	Do. ..	0	11	13	0
32	Do. ...	Mallathahalli	Do. ..	Do. ..	1	1	15	0
33	Do. ...	Do ...	Do. ...	Do. ...	0	10	14	0
34	Kolar ..	Ramachandra-pura.	A poor well-drained soil of laterite and red loam.	October 1888	1	4	25	6
35	Do. ...	Do. ...	Do. ...	Do. ...	1	2	25	9
36	Do. ...	Do. ...	Do ...	Do. ...	1	11	25	3
37	Do. ...	Do. ...	Do. ...	Do. ...	1	5	25	5
38	Do. ..	Malur Town	Do. ...	October 1874	3	0	35	7
39	Do. ...	Old Kurandahalli.	Do. ...	October 1888	2	2	25	8

Sandalwood from plantations in Mysore—(concld.)

Age of plantation as recorded.	Countings by Mr. Troup.		Countings by Mr. Marsden.	
	No. of visible rings counted on section.	Remarks on clearness of rings, &c.	No. of visible rings counted on section.	Remarks on clearness of rings, &c.
Years.				
52	24	Rings clear in places, indistinct elsewhere.	42	Rings not clear.
52	21	Rings indistinct, particularly on heart-wood.	20	Do.
49	32	Do. do.	32	Do.
49	27	Do. do. ...	26	Rings clear in heart-wood but confusing in the sap-wood.
31	23	Rings distinct except towards centre.	27	Rings clear, excepting the centre of the heart-wood.
31	21	Rings moderately distinct in parts.	23	Rings distinct
31	17	Do. do.	16	Do.
31	18	Do. do.	27	Rings not clear on account of a hole in the stem and its crooked shape.
31	22	Do. do. ...	23	Rings distinct.
31	13	Rings very indistinct ...	13	Rings not clear in the sap-wood.
31	19	Rings moderately distinct in parts.	21	Rings clear.
31	17	Do. do. ...	16	Do.
31	19	Rings fairly distinct towards outside, indistinct towards centre.	27	Rings not very clear.
31	25	Rings moderately distinct in parts.	23	Rings not clear. Heart-wood in the form of a black dumb-bell shaped impression
30	20	Rings usually indistinct ...	26	Rings eccentric, not clear.
30	24	Rings indistinct towards centre	26	Rings almost distinct.
30	28	Rings moderately distinct	29	Rings not clear.
30	34	Do. ...	30	Rings clear, but false rings numerous.
44	58	Rings very indistinct in centre, fairly distinct elsewhere.	42	Do. do
30	...	Rings impossible to count over most of the surface.	26	Rings not clear in the heart-wood.

NOTES FROM DEHRA DUN HERBARIUM.

No. IV.

Continued from "Indian Forester," XLIV, p. 564.

CASSIA AURICULATA, *Linn.*

BY R. S. HOLE, FOREST BOTANIST.

On account of the value of its bark for tanning purposes *Cassia auriculata*, Linn., is at present a plant of great importance in India and information is needed regarding its existing distribution and the possibility of extending it by cultivation in Northern India. Duthie (*Flora of Upper Gangetic Plain*, I, p. 294) reports that the plant occurs in Ajmer-Merwara and Bundelkhand and also in the districts of Etawah and Gorakhpur of the United Provinces. Whether it is truly wild in all these localities, however, requires verification. Specimens have recently been received at Dehra Dun from Mr. P. H Clutterbuck, Chief Conservator of Forests, which were collected in the Jhansi District and this appears to be the first record of the plant being found in that district. The plant was first noticed in the locality by Mr. C. T. Allen of Cawnpore, and at the request of Mr. Clutterbuck the area was subsequently visited in August last by Mr. G. O. Coombs, the Divisional Forest Officer, who has supplied the following interesting details :—

The area occupied by the plant, so far as is known at present, does not extend over more than about two miles of country along the right bank of the Betwa from about opposite Bhownra Ghat to Benda Surwai extending out from the river up some of the ravines for a distance of about 1¼ miles and covering approximately 1,000 acres in the Zamindaris of Shamsherpura and Benda Surwai in the Garotha Tahsil of the Jhansi District.

The plant is growing in a wild state scattered all over the ravines roughly 4 to 12 feet apart, bushes often coming up from under the shelter of Reonjha, Khair and other jungle trees.

The average height of the bushes is about 6 feet and the girth at base 4 to 6 inches, although some were observed as much as 12 feet high and 12 inches in girth at base The waste land on which it grows is heavily grazed by cattle, sheep and goats, but the *Cassia* bushes did not appear to have been browsed or damaged by grazing. All the bushes showed signs of what was apparently frost damage, the damage being severe in the deeper portions of the ravines but slight in the higher portions.

The soil is poor and contains kankar. The plant reproduces itself naturally and a few seedlings of the previous year were found in the area. It is estimated that about 500 maunds of dry bark might be obtained by clear felling the whole area which in a few years would yield another crop.

The local villagers know the shrub by the name of *dhobain* and make tooth-brushes of it for which it is apparently considered very good. It is also used for fuel and sometimes for thatching.

GIRDLING OF TEAK TREES IN BURMA.

BY A. J. BUTTERWICK, P.F.S.

According to the latest standing orders on girdling of teak, it is laid down that the "trees should be girdled so as to expose a continuous belt of heart-wood two inches broad." The writer on enquiry as to why the heart-wood exposed could not be less than 2 inches, was informed that perhaps the cut would heal up by calluses formed from the cambium of both upper and lower severed surfaces. To see whether this alleged occlusion would take place, the writer, on the 28th May 1918, girdled the following teak trees with a small hack saw, about $\frac{1}{16}$ inch thick (the thinnest obtainable)—

(1) Girth at breast-height 2′ 9″
(2) " " " 2′ 8″
(3) " " " 4′ 10

The thickness of the bark and sap-wood to be cut through was first ascertained by means of a solitary notch in each tree. To know whether the hack saw had penetrated into the tree this

depth, a very thin bamboo slip was inserted into the saw-cut and measured. The leaves of trees Nos (1) and (2) started wilting two days after the girdling, and in twelve days' time both trees were entirely leafless. As tree No. (3) after a week did not show any *signs of dying, it was regirdled with the saw a bit deeper.* The second girdling was quite successful, and the tree was entirely leafless within ten days of the operation. By October of the same year the three trees, when re-examined, did not show any signs of recovery in their crowns, but from just below their girdles a very healthy crop of stool shoots were found to have sprung up. These were assuredly formed from the reserve food in the stumps and roots. On the 14th June 1918, a little more than a year after the girdling, the three trees were again examined by the writer, and the three photos, which are published herewith (Plate 7,) taken. All three trees above their girdles have been effectually killed; and the bark is falling off from all. But the stool shoots which were produced last rains from below the girdles, are exceedingly strong and vigorous, as may be noticed from the photos. It appears, therefore, to be the case, that if the tissues in the bark and sap-wood of a teak tree are *completely and thoroughly* severed by a girdle round the tree, however narrow the line of section may be, the tree above the girdle will die, and the wound will not occlude and intercourse be re-established between the leaves and roots. It is admitted that the girdling was done at the beginning of the growing season, and different results may, perhaps, be obtained if the operation be done at the end of that season.

Incidentally another point of interest arises. In the "Concise Manual of *Sylviculture for the use of forestry students in India*" on page 25 it is stated: "This (arrest of circulation of sap) is done when a tree is girdled. A ring is cut by means of which the downward movement of the sap is prevented, and the roots are thereby deprived of all nutrition except what they derive from the water of the soil; meanwhile the leaves of the tree continue to transpire, so that the roots are called upon to supply the usual large quantities of water required to replace what is day by day evaporated from the surface of the leaves. The activity of the

GIRDLING OF TEAK TREES IN BURMA.

Tree No. (1) shewing the girdle and the shoots from below it.

Tree No. (2) shewing the dead tree above the girdle and the clump of shoots below it.

Tree No. (3) shewing the girdle and the shoots below it.

roots, thus shut out from their supply of nutrition, becomes exhausted, the leaves wilt and dry up, the necessary state of tension in the living tissues of the tree is not maintained, the rise of sap from the roots ceases altogether, and the tree dries up and dies." The above does not appear to be the case in the girdling of teak, for the leaves deprived of water from the roots certainly dry up and die first. In fact, although all the leaves of the tree may have dried up and fallen off, the portion of the same tree below the girdle, using the reserve food materials in the tissues of the stump and roots is yet sometimes able to send up vigorous coppice shoots (see Plate 7). This is in accordance with the explanation of the operation of girdling or ringing given on pages 168 and 169 of the Manual of Botany by R. S. Hole, which version appears, therefore, to be more correct than the one quoted above from out of the Manual of Sylviculture.

ON THE SPECIES OF *ZIZYPHUS* IN THE BOMBAY PRESIDENCY.

BY L. J. SEDGWICK, F.L.S., I.C.S.

The object of this paper is to point out the difficulties in the way of a clear understanding of this difficult genus, so far as it occurs in this Presidency, and to suggest the directions in which further investigation is required.

Apart from difficulties peculiar to the different species, there are certain general difficulties common to the whole genus. These are :—

(1) The tendency to dwarf habit.

(2) The extreme variability of armature.

(3) The variability in the vestiture of the leaves.

(4) The different appearance presented in the herbarium by fruits dried when mature and fruits dried when immature.

(5) The unreliability of characters founded upon the floral parts. The flowers of the *Rhamnaceæ* are so small and so constant in morphology that divergence is only possible within the narrowest limits. In particular, I

doubt very much whether any reliance can be placed upon the distinction between styles connate to above the middle and styles free from below the middle. This varies within the limits of one species and even in the same individual, being largely dependent upon the amount of nourishment available to the plant and the age of the flowers.

This paper is based on prolonged observation in the field and on an examination of the available material contained in five Herbaria, namely, of the economic Botanist at the Agricultural College, Poona, of the Herbarium of the late Mr. W. A Talbot, I.F.S., also at the Agricultural College, of St. Xavier's College, Bombay, of the Gujarat College, Ahmedabad, and of Mr. T. R. D. Bell, I.F.S., and myself. My thanks are due to Mr. H. M. Chibber, Father Blatter and Mr. Hallberg, and Mr. G. D Thanawalla for kindly placing at my disposal the material of the herbaria mentioned.

1. *Z. Jujuba*, Lamk. This well-known tree is extremely variable, and has often been altered by cultivation. Apart from the dwarf form which is described below, I find variation in armature, in size and shape of leaf, and in vestiture of the leaves. The leaves vary within the following extreme forms :—(*a*) very large, oval, up to 3 inches, (*b*) narrowly elliptic 1 x [illegible] inches, minutely serrulate, (3) rotund and with several large coarse teeth at the apex. This latter specimen (in Herb. Econ. Bot.) may, however, belong to the variety mentioned below. The vestiture of the lower surface varies in colour from pearly grey to deep golden yellow.

1 (*a*). *Z. Jujuba* var. *fruticosa*, H. H Haines. This is described by Mr. Haines in his " Forest Flora of Chota Nagpur" as follows :— " A densely branched thorny shrub 3 4 feet high, leaves often symmetrical $\frac{3}{4}$—$1\frac{1}{2}$ inches, elliptic to sub-orbicular, minutely serrulate or with 3 or more coarse teeth near the apex. Fruit globose, yellow or red, shining, $\frac{1}{3}$—$\frac{1}{2}$ inches in diam. In some respects it appears to me to come very near to *Z. nummularia*, with which it is sometimes confounded." Again in a note inserted as a pasted

correction slip in the copy seen by me he adds:—" It is probably a distinct species. The habit is very uniform. It is doubtless included in *Z. rotundifolia*, Lamk., in the Flora of the Gangetic Plain, between which and *Jujuba* it is intermediate "

Mr. Gamble in his Flora of Madras, Part II, accepts this variety and differentiates it from *Z. nummularia* by the vestiture of the leaves, the sculpturing of the disk, and the armature. With regard to the latter character, he says of this variety " both straight and recurved thorns strong" and of the other species " both straight and recurved thorns slender."

In the Carnatic often and in one specimen in Herb. Econ. Bot. collected by Mr. Chibber at Shirale, Satara District, this form appears as an extremely low shrub 1 to 2 feet above the ground and with leaves ½ inch or less. In these specimens the thorns are, in accordance with the very dwarf state, quite slender, certainly no less slender than the thorns of true *Z. nummularia* from N.-W. India On the other hand, there is no trace of vestiture on the upper surface of the leaves. Prior to the appearance of Mr. Gamble's work I had come to the conclusion that the only valid morphological character whereby the dwarf states of this variety could be separated from *Z. nummularia* was the vestiture of the upper surface of the leaves, which in *Jujuba* is quite glabrous and in *nummularia* is strongly appressed grey-hairy, in which case our Carnatic plant would be the former. Even this, however, is a dangerous character, since Mr. Calder informs me that one or two specimens of *Jujuba* in Herb. Hort. Reg., Calc., have leaves appressed hairy on the upper surface, and I have myself seen specimens of *Z. rugosa* in which the normally glabrous upper surface shows appressed hairs. The character of the disk (grooved in *Jujuba*, pitted in *nummularia*) requires observation when the flowers are out fresh (there are none at the moment of writing). But for the reasons given in point (5) of the introductory remarks this is a dangerous character to rely on. In the disk-lobes of a tiny Rhamnaceous flower the difference between a grove and a pit is slight; and it is possibly merely a matter of how the depression in the disk struck the individual author who first described each

of the two species. Apart from all these characters, there is the question of geographical area *Z. nummularia* is a Perso-Arabian plant, and abounds on the sandy soils of N.-W. India. In this Presidency it is, therefore, mainly confined to Gujarat and Sind, and I doubt if it comes south of the Tapti except very rarely Like many Perso-Arabian plants it is found far south in India occasionally. But I think one would not go far wrong in refusing to assign to *Z. nummularia* any specimen found in this Presidency unless the upper surface of the leaf is appressed grey-hairy.

2. *Z. nummularia*, Wf. and Arn. There is nothing more to be added about this except that the name *Z. rotundifolia*, Lamk., adopted by Cooke in his Fl. Bomb. Pres., is not even mentioned as a synonym by Mr. Gamble, and can, therefore, be now abandoned, it having been always doubtful whether Lamarck was describing this species or not.

3. *Z. trinervia*, Roxb. (= *Z. glabrata*, Heyne). This tree can be recognized by the pale slender zigzag branchlets, narrow glabrous leaves on slender petioles, absolutely glabrous, and with obscure nervules.

The main question for Bombay botanists is whether the species should be included in our flora at all.

It has always been included on the strength of specimens found by Woodrow, Cooke, Mr. Bhide and others at Surat and Ahmedabad. During three years' work around Ahmedabad Mr. W T. Saxton and I failed to find it. Mr. Bhide, to whom we referred, told us that he thought he had it close to Ahmedabad Railway Station. The only place where I have seen it is in the village site of a Bhavnagar State village a little west of Gogha in Kathiawar, where it was quite a considerable tree. These records distinctly imply that the species is not indigenous in the Presidency, and should, therefore, be excluded in future floras.

A very interesting point is raised by a specimen, Blatter and Hallberg No 9298 from Perim Island in the Gulf of Cambay, which resembles *Z. trinervia* in every particular except that it is typically armed with twin spines and here and there minutely tomentose. Having regard to the great variability of armature

displayed by the genus, the abnormal character of the locality (a very small, windy island), and the proximity to Gogha and Surat, I think this specimen must be placed here. But since Perim I. was constantly inhabited by pirates and their followers, this record gives no additional force to the idea that the species is indigenous.

4. *Z. Œnoplia*, Mill. This abundant shrub is well known and easily recognized by its scandent habit, narrow, pointed, distichous leaves with appressed *silky* yellow vestiture below. It is liable to variation in two directions which I distinguish as follows :—

(*a*) *forma robusta*. Very stout and strongly armed, not truly scandent. Leaves more obliquely cut away at the base. Vestiture of under-surface denser, and including some tomentum below the yellow silky hairs Open sunny situations.

(*b*) *forma mollis*. Delicate. Leaves smaller rotund-ovate, no tomentum, silky vestiture grey instead of yellow, much less pronounced, sometimes practically absent. Shady situations in wetter tracts.

In addition to these variations the plant is extremely liable to spike disease (witches' broom).

5. *Z. xylopyra*, Willd. More correctly *Z. xylopyrus*, as adopted by Mr. Gamble. The essential difficulty is whether our Western Ghat form with glabrous leaves is not really a distinct species.

I have not been able to obtain Willdenow's original description, but I conclude that he described the leaves as having some kind of vestiture beneath. Lawson in Hooker's F. B. I. (I. 634) says—"Covered with soft, pale pubescence beneath." Cooke (F. B. P, I. 242, but clearly not working from Bombay material, says—"Covered with white or yellowish tomentum beneath." Mr. Haines (op. cit.), says—"Leaves more or less permanently pubescent beneath." Brandis (Indian Trees) says—"Leaves pubescent or tomentose beneath." Talbot, on the other hand, (Forest Flora, I. 298), speaks of the "glabrescent under-surface." Mr Gamble (F. Mad. Pr., Pt. II, 221) says :—"The leaves are very white woolly when young, but nearly glabrous when old." There is,

however no doubt whatever that the small tree with the globose woody fruits, which we call *Z. xylopyra* in this Presidency, has leaves which in all conditions *and at all ages* are perfectly glabrous except for slight pubescence on the petiole, and a very little inconspicuous appressed pubescence on the main nerves on both sides. There is a great deal of material available from the whole region from Khandesh to Kānara bearing this out Nor is this dependent upon edaphic or climatic instances. Specimens from the crest of the ghats and from particularly xerophytic places far inland, though differing in size and in armature, are absolutely constant in the absence of vestiture from the leaves. I referred to Mr. C. C. Calder, Curator of the Herb. Hort. Reg., Calcutta, who writes :— "In Herb., Calc., Willdenow's *Z. xylopyra* is, with the exception of one specimen (Woodrow No. 3, Khandala) a *strongly* tomentose species. . . . A specimen from Mt. Abu is quite as strongly tomentose as specimens from Eastern India." This last remark is borne out by specimens from Mt. Abu, in Herb., Blatter and Hallberg as well as by a specimen (Sedgwick, 1162, in Herb. Guj. College, Ahmedabad), collected near Modasa in the extreme north of the Presidency. The character of the fruits follows that of the leaves and the fruits of our Western Ghats form are entirely or almost entirely free from tomentum at all stages.

Whether we are to regard this as a separate species or not depends on our conception of what constitutes a species I have not found any transitional states in the material examined. There seems to be an abrupt jump from the tomentose North Indian form to the glabrous Western Ghats form. Whether there are any other differences I cannot say. It would be of great interest if some Forest Officer would compare samples of the timbers and get comparative chemical analyses made of the fruits, since there is a feeling nowadays among Systematic Botanists that physiological as well as external morphological differences should be considered for the purposes of classification. At any rate, we have here a special geographical form analogous to the geographical forms of birds, for the discrimination of which ornithologists have adopted the trinomial system of nomenclature, and perhaps analogous to

the edaphic forms so much studied in Europe in the case of *Calamintha, Gentiana* and other genera occurring on and off limestone. We may, therefore, for the time being call our Western India Tree *Z. xylopyra*, var. *glaberrima*, and leave open the question whether it should take rank as a species.

5(*a*) *Z. xylopyra*, var. *microcarpa*, Talbot F. F. I., 298. This is an extremely obscure form. I quote the whole of Talbot's remarks *in extenso*: "Var. 1 (*microcarpa*) differs from *Z. xylopyra*, principally in having an entire style with a 3-lobed stigma. Fruit ovoid, pointed or depressed at top, ·5"—·75" in diameter with a thin or thick pericarp and a very rugose bony nut. A rambling shrub or small tree common throughout the Deccan in dry, deciduous forests, also found near Gokak in the Belgaum district; very closely allied to, if not identical with, *Z. caracutta*, Roxb, from Mysore; it has, however, longer petioles than are figured in Roxburgh's original drawing of that species in the Calcutta Herbarium. Col. Prain is of opinion that it is probably a distinct species. I have considered it a variety of *Z. xylopyra*."

In the first place, as regards distribution I cannot help thinking that Talbot may have been in error in reporting this as "common throughout the Deccan." There is not a single sheet in the Poona Herbarium nor in the material collected by Father Blatter and Mr. Hallberg which can be referred here, and there is only one sheet in Talbot's own herbarium, and that from Gokak.

In the second place, the appearance of the dried fruits in Talbot's Gokak specimen give the impression of a fleshy and not a woody fruit.

The possibility of hybridization should not be lost sight of in India, and if I am right in supposing that this is a rare form it may be a hybrid between *Z. Jujuba* and *Z. xylopyra*. Further elucidation is very desirable.

6. *Z. horrida*, Roth. This is a rare plant. It was unknown to Talbot. Stock's specimens in Herb. Hort. Reg., Calc., are without assigned locality. It appears from the floras that it has been found at Bellary. Gamble gives "Karnul and Mysore."

I refer here No. 9035 (Blatter and Hallberg) from Khandala. This is in a sterile condition. It has strong branchlets, very heavily armed, the straight spine of each pair being fully $\frac{1}{2}$ inch long. The leaves are very coriaceous, glabrous and shining above, glabrous beneath, $\frac{3}{4}$ inch rotund, but acute and with a pronounced mucroniform tip.

Further elucidation of the distribution of this plant is very desirable.

7. *Z. rugosa*, Lamk. Even this well-known plant shows variations. The armature consists normally of short solitary deflexed spines. Sometimes, however, there is to each such spine a second spine pointing upwards. The leaf apex is usually obtuse, often erose, but occasionally shortly and abruptly acuminate. Normally the upper surface is glabrous and very shining. But a specimen collected by Mr. H. M. Chibber in Khandesh (Herb. Econ. Bot.) shows leaves appressed hairy above, and in this particular is matched by a sheet from Ravi in Assam collected by Mr. A. C. Chatterji.

AN IMPROVED METHOD OF CULTIVATING LAC.

BY W. A FRAYMOUTH, F.C.S.

The usual contractor who works a lac forest does not concern himself about the future prospect of the forest beyond the period of his lease. He spreads just that minimum of brooc lac that will allow him to get a return for the money that he has expended. During the last crop of his term, he systematically robs the trees of everything he can get, for he can never be sure that he will be the owner of the crop to come.

The lac insect is subject to periods of intensive reproduction which are always followed by periods, during which their number is greatly reduced from various causes. A study of the prices of shellac during the last forty years will show that there have been periodic booms and slumps, which are repeated every seven years or so. These fluctuations in the price of shellac are due to the

irregular way in which the insect either swarms vigorously or fails to reproduce itself, accentuated by the habits of the lac collector.

In the first year of the cycle, *i.e.*, when three or four crops have failed, and when there is a great scarcity of lac in the jungle centres, the contractor is usually bankrupt and this is exactly the time that he should spend a lot of money in spreading brood-lac. It is at this moment that he usually fails to spread any lac and further robs the forest of even the little that is to be found. He then gives up his lease or begs that he may be let off his rent due for the lease.

It is at this stage that the markets of London and New York find their accumulation of stocks decrease, with the result that the price of shellac rises, to be followed slowly by higher prices, in Calcutta. The jungle contractor hearing of higher prices now thinks it is time to gamble again, so the lease is taken up again, probably just at the time that abundant reproduction of the insect starts. Then follow: a year in which the insect swarms well: a year in which much lac is taken and when the insect swarms well, and finally a year or two years, when in spite of no artificial propagation, a bumper crop appears. Nature then steps in to reduce the number of insects. Meanwhile, there follows the natural consequence of over-production: low prices. Prices for sticklac drop so low (Rs. 4-8 per maund in 1913) that it is not worth while for the contractor to take much lac, and so he leaves sufficient on the trees to spread naturally. We are now (1918) at the point in the cycle when having seen the insect almost wiped out in 1916-17 we can expect better reproduction, but our present cycle is irregular, because of the huge consumption of shellac for war purposes.

The stocks of lac of any kind, all over the world, are lower than they have been found for 50 years. The last few crops have been so bad that lac has disappeared from many forests.

Until the Government took control of shellac prices had risen to a height (Rs. 460-8 per cwt.) that is actually the double of previous highest records. With a half control in India and a full control at home, no one can say what the proper price of shellac should be.

It will thus be seen that the old conditions are calculated to interfere with any kind of regular working of the lac forests.

The next inference is that when sticklac is immature, *i.e.*, before the insect swarms, the resin contains a large amount of combined water. Lac resin in this state melts at a lower temperature than when the water has dried out. The Mirzapuri lac manufacturer will pay a higher price for such "green" sticklac and consequently it has become customary to cut lac in March-April (the 'Baisakh' or spring crop) which would not have been mature until mid-July when the larvæ swarm. It is evident that to take nearly all the lac two months before the new brood escapes, is to destroy future reproduction.

If this green sticklac is taken directly into a shellac factory without the opportunity to ferment and heat, it is possible to wash away all dye and mineral matter, after crushing, to produce a very pure seedlac but as sticklac is handled nowadays, the dye (which is the immature larvæ) ferments, producing heat, which causes the lac resin to melt and mix itself with animal matter, sand, etc., after which it is very difficult to refine. It was after some years of research to find proper methods to produce refined lac of good colour from such ordinary spoilt lac, that the writer discovered that the best way to refine lac is to allow nature to refine it. At the same time, this method allows nature full scope for her efforts to reproduce more lac.

As a first principle, no sticklac should be taken out of the forest before it has been allowed to yield its swarm of larvæ to other branches of the trees. Although the exact time of swarming varies in different parts of India on different species, I confine myself to what I consider the best species and climate for commercial lac operations, *i.e.*, the Ghont (*Zizyphus xylopyra*) in the forests of Damoh, Saugor, Jubbulpore and Central India. The colour of the lac is good, and trees require no extensive pruning, it is only necessary to throw a piece of broodlac on to the crown of the tree to find that the larvæ will drop on to the whole of the lower branches. The swarming occurs in mid-July and in mid-November and usually lasts three weeks.

Our first measure is to prevent theft during the months of May, June and July, and the most necessary step is to cut out and take away all sticklac from distant and inaccessible jungles, so that the work may be concentrated into those areas which are accessible and easy to supervise. As soon as the yellow tips appear on the top of the cells (end of June), the workers go out and cut off all the branches which carry lac. These branches are thrown on to the top of other Ghont trees and are allowed to remain there while they yield their swarm. This general cutting of the branches affords the necessary amount of pruning to the trees. It is essential that the whole of the lac should be cut and spread.

If labour is available after the swarming in early August, as much as possible of the sticks covered with empty ("phunki") lac are collected, brought in to godowns where the lac is scraped off, dried and cleaned free from stick, sand and dust If labour is not available, the whole of this "Baisakh" crop may be left on the trees until the "Katik" (cold season) swarm appears. The rain and sun will only clean and bleach the lac. Some have feared that great losses of lac would occur. This is not so, if thieves can be kept away. Others fear that the loss of weight between green and "phunki" lacs will cause less revenue. This is not so, for every lac manufacturer knows how to discount water and dye in sticklac that he purchases, for he knows that these will not produce shellac.

As soon as the yellow tips appear at the end of October, the workers go out again and cut all branches which carry lac. These are thrown on to the other trees, particularly on to those trees, which having been cut in July, now have fresh growth.

As soon as all the lac has been spread, the workers start collecting every stick of "phunki" lac from the "Baisakh" crop, and as soon as the "Katik" (winter crop) lac has yielded some of its swarm to the trees (it is not necessary to await the complete evacuation of the cells), it is collected, the whole yield of lack-covered branches are scraped free from the dry empty lac which is then cleaned thoroughly, all stick, sand and dust being removed.

The actual weight of this perfectly clean product will not appear as even one-half of the weight of the previous yields of lac from any given forest, but as the buyer of the sticklac always quotes his price on a clean lac ("bewlee"), the value of the clean product will be almost double that of the previous harvests.

Thus our method aims to use the "Baisakh" crops particularly as a seed crop, although we collect all the empty cells of resin that can be got, and that the "Katik" crop is used as a commercial crop. The greatest advantage of this routine is that it is always easy to arrange for labour in October and November and the lac is handled and transported in the cold weather with the result that it is not spoilt by rain.

The dry "phunki" lac requires practically no refining. We crush to an even size of grain and wash thoroughly, cleaning the resultant particles of resin to produce a refined lac with some 7 per cent. of insoluble impurities. It is of course possible to melt this seedlac, or "grainlac" as it is called, to produce shellac, but as shellac contains 3 to 5 per cent. of insoluble matter and as almost all refined lac reaches the consumer to be plunged straight into a solvent (alcohol, soda or borax), there is no good reason why we should spend Rs. 10 per maund to manufacture the special form of lac, shellac.

These methods have been introduced since the year 1916 in the leases in Damoh Division, which had yielded some 300 clean maunds of lac in the year before. We spent Rs. 3,000 in propagation then to produce 650 clean maunds of lac in 1916-17, paying the sum of Rs. 14,285-6-0 as royalty to the Forest Department, while the Esociet Company made equally good profits besides.

During last season 1917-18, we spent over Rs. 7,000 in propagation to produce 1,400 clean maunds of lac, even under the conditions of a crop that failed. Owing to war conditions, it was not possible, to export grainlac at present and so the clean sticklac was sold, as it is, to return a royalty of Rs. 20,000 odd to the Forest Department, while the Esociet Company received a

like sum as profit. Could we have exported, we should have paid the sum of Rs. 32 × Rs. 1,400 – Rs. 44,800 as royalty.

In Panna State the methods have been applied for two years. The highest previous revenue in any one year had been Rs. 12,000 on account of lac. Last year, the Esociet Company paid Rs 42,000 as royalty, and then made a like profit in addition.

In my opinion, none of these years have seen the above method applied as thoroughly as I would wish, and I regard Rs. 10,000 as the minimum sum that should be spent on propagation alone in the Damoh forests.

EXTRACTS.

THE TIMBER INDUSTRY.*

BY PERCY GROOM, M.A., D.SC., F.L.S., PROFESSOR OF TECHNOLOGY OF WOODS AND FIBRES, IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

This paper will mainly deal with the extent to which technical science can aid or has aided in promoting the timber industry in this country, and the utilization of the timber resources of the British Empire. Although it is obvious that practical details in trade will constitute limiting factors of the extent to which organized application of technical knowledge can be of immediate commercial and imperial service, little consideration will be given to obvious practical questions, such as the impending revision of the relations between employer and employee; the wisdom of improved organization of the timber trade along lines that are in the interests of the trade, the nation, and the Empire; and the effect of tariff reform.

The special qualities of timber that render it all important in daily life may perhaps be best understood if we consider the

* Paper read before the Royal Society of Arts on May 15th, 1918.

demands made on wood in the living tree, which is exposed to various vicissitudes during its prolonged existence. The wood at the base of a tree trunk has to withstand tons of pressure per square inch, while the trunk has to resist the bending action associated with its columnar form and the shearing tendency of its boughs. The trunk and branches have to resist shock caused by gusts of winds acting on a large head of foliage. Yet the young wood of the twigs or outer parts of the trunk must possess a certain degree of extensibility and toughness, as opposed to brittleness, so that they can endure change of shape under shock. Since one essential function of the wood is to conduct rapidly water to the leaves, wood must necessarily contain water channels, and therefore be an excavated, not a solid material. And since the water conveyed contains substances in solution, wood is capable of impregnation by watery solutions of dyes and preservatives. Remembering the great heights attained by certain tree-trunks, and the immense load of branches, it is necessary that wood in the tree should be relatively light in weight when compared with its strength and stiffness. Finally, it is evident that wood in the tree must possess a certain degree of durability.

These various qualities essential to wood in order to make possible the existence of a tree render timber a material having unique qualities as regards strength, elasticity, extensibility, and above all confer upon it a general superiority to metals as regards comparative weight and strength. The feeble powers possessed by wood of conducting heat, the relative ease with which it is worked and the great variety of timbers available, enhance its value and add range to the variety of uses to which it can be put as a structural material. Moreover, in certain situations, or when appropriately treated, wood is far more durable than iron; and can be subjected to processes after which it successfully withstands temperatures at which iron flows away as a molten liquid. Consequently as a structural material wood subserves purposes too familiar and numerous for enumeration.

When disintegrated it yields *fibres* that provide paper and cordage. While as a *chemical* complex wood is a fuel, and is the

source of substances as diverse as charcoal, alcohols, acetone, formalin, artificial silk, turpentine dyes, scents, and drugs.

New uses for wood are constantly being discovered and old uses being increased, so that with the advance of civilization the consumption of timber per head of population steadily rises, despite its replacement for certain purposes by other materials, such as iron and ferro-concrete. Hence in this country and the British Empire we know that there will be an ever-widening demand for timber.

The amount of wood used by this country may be estimated by a consideration of the imports in 1913.

In 1913 the values of the imports of timber into the United Kingdom were:—

		£
Softwood (conifer) logs, sawn, planed, etc.	...	22,800,000
" pit-timber ...	...	4,400,000
" wood-pulp ...	...	5,425,000
Total	...	32,625,000
		£
Hardwood, oak logs ...	...	1,700,000
" wood manufactures ...	...	4,600,000
" teak, mahogany, furniture, etc.	...	3,800,000
		10,100,000
Softwoods and hardwoods, Total ...	...	£42,725,000

In addition, there was consumed a large amount of wood grown in the United Kingdom.

The largest item is represented by softwoods which grow in the north temperate regions, and are actually exported thence to tropical and southern countries. In the British Empire there is therefore only one great source of supply, namely, Canada. The supplies of softwoods are steadily decreasing in amount and receding in accessibility. The depletion of supply is particularly marked and serious in reference to constructional softwood of

large dimensions and good quality. At present Douglas fir (British Columbian pine), some pitch pine in the United States, and some Scots pine in the recesses of Russia, represent such large timber. When these stocks have vanished they will probably never be replaced, because in modern forestry operations conifers in artificial forests are felled at the age of seventy to eighty years, as they then yield the optimum return.

It is therefore evident that the price of softwoods will continue to rise, and the more so with the increasing demands made by the growing southern nations in Australia, South Africa, and elsewhere.

What steps are to be taken to alleviate the threatened situation? In answer, four possibilities suggest themselves:—

1. Increased production of softwoods in this country, and the British Empire generally, by *afforestation*.

2. Partial substitution of hardwoods grown in British Colonies and Dominions for softwoods imported from foreign countries.

3. Maximum avoidance of loss and waste.

4. Further economy in the usage of timber.

Dealing first with the last possibility, the question arises: Is this country extravagant in its consumption of wood? The answer must be in the negative, since the subjoined table proves that the annual consumption per head of population is less than that of any other Great Power with the solitary and small exception of Italy.

APPROXIMATE ANNUAL CONSUMPTION OF WOOD IN CUBIC FEET PER HEAD OF POPULATION.

United States	260
Canada	193
Russia	63
Austria-Hungary	57
Germany	36·6
France	24·6
United Kingdom	14
Italy	13

Although the consumption of wood in this country is not extravagant, I shall show later in this paper that not inconsiderable economy is possible.

The question of *afforestation* in the United Kingdom has been repeatedly considered by Governments. The scheme appealed rather to statesmen than to politicians, and as a commercial proposition promised only a modest return at a distant date. Recent experience has, however, introduced a broader outlook, which recognizes the direct and indirect effects of forestry upon agriculture, rural repopulation, and the defence of the country, so that sanction has been given to a scheme in Great Britain. Years ago I endeavoured to interest the War Office in a scheme of combining an increase in the Army with the initiation of afforestation that should be carried out by a staff mainly recruited from men who had served in the regular Army or were auxiliaries in the Army. It is to be hoped that some such plan, taking cognizance of the existence of the Royal Air Force, will be considered for adoption throughout the British Empire.

The success of any measures, including afforestation, designed to improve conditions in this country as regards the timber industry, will depend finally upon the extent to which the pertinent scientific and technical knowledge is acquired and applied. The remainder of this paper will therefore be devoted to a survey of the fundamental facts and principles that have been learnt through research, and to some mention of problems calling for solution.

The chief, but not exclusive, problem of afforestation in this country is the successful production of coniferous timbers or softwoods. Great Britain with its temperate island climate is well suited for the growth of conifers, and taking into consideration its ranges of temperature, altitude, and soil, I am of opinion that the British Isles are better suited than any other country in Europe for the cultivation of a wide range of conifers. The main question, however, is not the successful growth of the tree, but the successful production of timber of proper quality; the former does not necessarily involve the latter. Yet we do know

that good coniferous timber can be grown in this country. Years ago, by means of mechanical tests at the Imperial College, it was discovered that timber of Scots pine grown even in the South of England is suitable for paving the streets, while last year mechanical tests proved that not only in the South of England, but also in the highlands of Scotland the Scots pine can yield slow-grown timber that is equal to the highest demands ever made on wood, namely, use in vital parts of aeroplanes.

Now not only do the timbers of different kinds of trees differ in their qualities, but the timber of one and the same species of tree varies according to the conditions under which it is grown Therefore if timber of the best quality is to be produced, it is necessary to be able quantitatively to estimate the mechanical values of different samples, and to analyze the conditions under which these have grown, so that in forestry operations the correct treatment may be adopted in connection with each species of tree. Some of the valuable results obtained in this connection by the researches of botanists, foresters, and mechanical engineers, may now be considered.

Timber is not strictly a material, but is an elaborately designed structure, consisting of solid wood substance excavated so as to form a framework. The elementary *structural units* of wood are hollow; their solid walls and sometimes their cavities contain water; the portions of their cavities unoccupied by water are mainly filled with air. When a piece of wood is completely dried its weight may be regarded as wholly due to the solid framework of wood-substance (though this is not absolutely correct). Inasmuch as the specific gravity of the wood-substance of all kinds of timbers investigated is approximately the same (*viz*, about 1·55 or 1·56), it follows that the so-called specific gravity, or the weight per cubic foot, of absolutely dry timber *is a sufficiently correct indication of the* amount of wood substance in it A "heavy" timber has much wood-substance, a light timber has only little wood-substance. Hence it follows that the strength, stiffness, hardness, and heating power

of timber tend to be proportional to their respective specific gravities, so long as they contain the same percentages of water. This tendency is at a maximum when different samples of one and the same kind of timber are in question.

In the case of the most important of all coniferous timbers, the Scots pine, the specific gravity and compressive strength of the heaviest wood are more than three times those of the lightest wood. If comparison be made of the timber of this tree grown on similar soils and with similar treatment, but in different climates, changes in structure of the wood are revealed to the naked eye. As the climate becomes colder growth is slower and the annual growth-rings of the wood are narrower, but this diminution of the thickness of the rings takes place more at the expense of the soft light spring-wood than of the heavier, harder red summer (autumn) wood. Hence the narrow-ringed wood is heavier and stronger. When, however the climate becomes too severe—as in regions nearing the Arctic zone—the attenuation of the growth-rings continues, but the wood is lighter in weight and weaker; such is the red deal exported from the White Sea. A knowledge of these facts rendered possible during the present war the correct anticipation of the occurrence in the highlands of Scotland of slow-grown, light Scots pine eminently suited for use in aeroplanes. Variations in the soil and in the light to which Scots pine is exposed cause corresponding changes in the structure and properties of the wood. One example of the comparative effects of knowledge and ignorance in these matters may be cited in reference to the present war. Germany having made thousands of tests and observations on the structure of Scots pine growing in various forests of that country, was able instantly to secure rich supplies of this wood of exactly the quality required for aeroplanes. In this country, until the present war began, we did not know the mechanical values of any kind of timber whatsoever growing in the United Kingdom, still less did we know the values for the different varieties of one timber, nor where these varieties were to be found: we were compelled to find and then test the woods that might be suitable.

Results similar to those obtained in regard to Scots pine hold good for Norway spruce (*Picea excelsa*), as is proved by the subjoined values obtained by Professor Janka on this wood grown in Austria:—

Width of annual ring (in millimetres).	Specific gravity (× 100).		Compression parallel to the grain (crushing stress in kilograms per square centimetre).	
	Seasoned	Absolutely Dry.	Seasoned	Absolutely Dry.
·5—1	44·9	41·7	397	743
1—1·5	44·3	41·3	395	729
1·5—2	43·1	40·2	386	708
2—2·5	41·9	38·9	364	666
2·5—3	41·3	38·4	353	647
3—3·5	39·9	37	339	622
3·5—4	40·2	37·2	342	61[illegible]
4—4·5	39·1	36	314	581
4·5—5	40·2	36·8	308	554
Above 5	38·1	34·9	306	510

By way of contrast to the softwoods discussed, hardwoods of the type of the oak and ash may be considered. In these, as the growth is more rapid, the increased width of the annual rings is often mainly caused by disproportionate additions to the hard, heavy, fibrous summer-wood produced outside the soft, weak, porous spring-wood. In the case of the oak there is probably a limit to this tendency, as towards the south of Europe oak timber, though wide-ringed, is slightly softer than that grown in our own climate. The weakness of narrow-ringed porous ash-timber is familiar to all practical men, especially in connection with those trees that have grown slowly under the influence of excessive shade.

In timbers of this type there is also a decline in weight and strength when the annual rings are of the same thickness, but there is a wider zone of porous wood (due to a larger number of series of pores). Monsieur Thil found for instance in oak, where each annual ring was half a centimetre in thickness, that the tensile strengths of three samples showing respectively 1, 2 to 3

and 3 to 4 series of pores in the spring zone were 17·1, 13·6, and 12·7 kilograms per square millimetre.

The tendency for opposite effects to be induced in pine and ash timbers by widening or narrowing of the annual rings explains one practical matter in connection with parts of aeroplanes in which the wood is used in the form of thin laminæ or is spindled out; the pine must not be wide-ringed, whereas the ash must not be narrow-ringed. Another practical lesson in this connection may at once be learnt by anyone observing the variety of qualities or grades of blocks of Scots pine paving streets in London. He will then note that in certain parts of London the use of inappropriate grades of this wood causes great economic loss and unnecessary public inconvenience.

Mechanical tests on timbers, apart from providing one of the bases for sound forestry, are of value in providing the necessary information as to the minimum dimensions required in constructional wood used for specific purposes. They thus render possible the utmost economy and the substitution of one wood for another.

Afforestation in Great Britain can yield considerable supplies of softwoods only many years hence; consequently the provision of substitutes in the form of hardwoods grown specially in British tropical Colonies would be of great economic importance if practicable. There are, however, both technical and commercial difficulties in the way.

The extensive use of softwoods as structural material is due to several sets of factors. First, coniferous trees grow in the north temperate regions, forming forests that are pure or contain large numbers of the same species of tree. Softwoods are thus accessible and can be obtained cheaply: this is especially true of Baltic softwoods. These coniferous timbers are usually easy and cheap to work, often display high strength-values when compared with their weights ("specific gravities"), tend to shrink less than hardwoods, and generally are more easily and rapidly seasoned than are the latter; while as sources of fibre and paper they yield a very high percentage of fibre.

On the other hand, the hardwoods abounding in the vast forests of the British tropical and southern Dominions and Colonies are generally more distant; for even the West African Colonies are farther away than the Baltic. Moreover, the hardwood trees in them grow together in mingled confusion, hundreds of different species growing side by side. Consequently definite kinds of hardwoods are less accessible than are softwoods.

Yet many of the hardwoods have certain advantages on their side. In moist, tropical countries their growth is generally much more rapid than is that of the northern conifers, and there is no present demand for certain of them, indeed in some cases they represent obstructions that have to be removed and destroyed. Considering the amount of loss involved in the artificial destruction of tropical trees, the utilization of such waste wood forms a problem of first-class economic import. Investigations will show that numbers of these inferior neglected woods can be utilized either as substitutes for softwoods of the better quality, or as fibre-yielding material to be used in the manufacture of paper, or chemically to yield alcohol and so forth.

As regards hardwoods of better quality and often greater weight, some may be employed as substitutes for hardwoods—such as oak, teak, and mahogany—that are partly imported from non-British countries, or may be more vigorously exploited in foreign lands. But to accomplish these aims full information as to the mechanical and working properties of such woods is required. We have very little detailed information as to the mechanical and other properties of such timbers. Yet investigations conducted during the present war have revealed the suitability for use in aeroplanes of certain mahoganies and other hardwoods from British West Africa, Papua, Queensland, British East Africa, and India, and of certain softwoods from New Zealand and British East Africa.

These considerations lead once more to the study of the structure of timbers, whose significance in affording guidance to the qualities and uses of woods has already been indicated.

Research into the structure of timbers is also necessary as a means of rendering possible the critical *identification*. Such identification is needed in order that a person shall secure exactly the kind of wood that he requires. At present the commercial nomenclature of timbers is in confusion For instance, in various parts of Australia the same names are applied to different timbers, and different names to the same timber: such practice militates against the sale of these woods in this country, for it may be said that every kind of wood has certain uses for which it is fitted better than any other. To select another example: a number of kinds of wood varying widely in colour, structure and properties are sold in this country under the name of West African mahogany. Apart from the disappointment experienced frequently by purchasers, and the consequent tendency for West African mahogany to be discredited, this particular case is not devoid of national significance. I believe that the most motley array of such so-called mahoganies before the war came from the German Colony, Cameroon, which did not export anything like the same quantities as the British and French Colonies. The natural result would be that the wrong attachment of the name of mahogany to the German spurious mahoganies would inflate their price, while lowering the price of British and French genuine woods In importing the latter Germany would profit doubly.

So far no reference has been made to the great part played by water present in wood. By exhaustive tests it has been proved that the strength, stiffness, and hardness when measured by indentation), of one and the same piece of wood vary inversely as the amount of water contained in the wood substance itself. The table already given shows that in the case of spruce the absolutely dry wood has far greater resistance to crushing than has the merely seasoned wood. The pliability and ductility of wood, on the contrary, increases with rise in the water-contents, and greatly so if this be accompanied by rise in temperature. Wet-steamed wood can, therefore, be compressed to form railroad keys or bent to yield furniture; whereas very dry wood permits of only slight deformation, and in this sense is brittle.

So far two reasons exist in favour of drying wood before use—decrease of weight and improvement of mechanical qualities; and these are accompanied by a third, which is associated with the changes of shape and dimensions of wood as it absorbs or emits water

When once all the water has been removed from the cavities of the wood and even before this when drying is relatively rapid) wood shrinks steadily as it continues to dry. Shrinkage is far the least along the grain; while across the grain it tends to be much greater circumferentially than radially. Hence, during drying, a piece of timber would undergo considerable distortion were it not that wood possesses ductility. As a matter of fact such distortion in the form of warping or twisting often does take place in bastard-cut boards or planks when the process of drying is carried on too rapidly, and the warping may be accompanied or replaced by splitting in a radial plane.

This differential shrinkage along and across the grain partially accounts for the practice of cutting up highly figured wood and knotty burrwood into thin and relatively small veneers. Somewhat akin to this veneering process is that of the manufacture of ply-woods. In three ply-wood, for instance, as the outer sheets or plies have their grain in a direction at right angles to that of the middle sheet or ply, the outer and middle plies tend to check each other's tendency to shrink or increase in surface. However, since wood is much stronger along than across the grain, the three-ply possesses a combination of transverse and longitudinal strength impossible in a single piece of the thickness equal to that of the three-ply. In ply-woods the plies glued together may number from three up to seventeen, or perhaps more and may be composed of a single kind or several kinds of wood. The manufacture and use of ply-wood is only in its infancy, and is bound to increase greatly, as, apart from the merits already mentioned, it renders possible the structural utilization of cheap and relatively weak woods, which, if desired, can easily be impregnated with substances that render them decorative, fireproof, or resistant to decay. While ply-wood and the woods yielding

them are practically exclusively imported from foreign countries there certainly exist in the various countries of the British Empire, timbers that are not being utilized at all or to best advantage, but yet are eminently fitted for use in ply form. But our knowledge on the technology of ply-wood requires amplification by research on a whole series of problems concerning the woods and adhesives suitable.

To return to the question of the relations subsisting between wood and water, it is known that a piece of wood continues to dry until at least its surface is in moisture-equilibrium with the water-vapour of the surrounding air. Thereafter it will absorb or exhale water according as the air becomes drier or moister, so that it is always shrinking or swelling. By limiting these interchanges of moisture, coatings of varnish, paint, and the like reduce such movements, but up to the present no one has solved the profoundly important problem of rendering wood absolutely impervious to moisture.

The preceding remarks provide sufficient justification for the *seasoning of timber*. Such seasoning was originally, and is still usually, accomplished by storing the felled wood in the open air, with or without a roof to screen it from rain and direct sunlight. This so-called "natural seasoning," being dependent upon climate, is prolonged and irregular, sometimes in abeyance and at other times too rapid. The prolonged storage not only ties up capital, but also involves loss of wood through decay or boring insects; while its occasionally excessive rapidity introduces loss due to case-hardening, warping, or splitting

The early discovery that seasoning is the consequence of a process of desiccation evoked the drying of wood by artificial heat. Primitive methods cause unduly rapid superficial desiccation and consequent development of defects (splits, brittleness, and so forth). Improvements including the regulation of temperature, moisture of the air, and air-currents in a drying chamber or kiln have rendered possible the balanced drying of the inner and outer parts of the timber, and have culminated in modern methods by which wood subjected to the severest strains that it ever

encounters, namely, in aeroplanes, can be reliably seasoned in kilns. These results have been attained solely through the most careful research, involving the use of instruments registering the changes in temperature and moisture in kiln and wood, and including investigations into the cause of such defects as brittleness, case-hardening, collapse, explosive splits, and so forth. Not all woods are artificially seasoned with equal facility. For instance, the oaks among hardwoods and swamp cypress among softwoods require special and careful treatment ; on the contrary, when compared with hardwoods, softwoods are more easily and rapidly seasoned, and can be safely exposed to higher temperatures, as their structure is less complex and their shrinkage generally less. Hence experiments are required to reveal the best, including the most economic treatment of timbers of different kinds and different dimensions. Even when wood and dimensions are the same the most economic treatment will depend on the use to which the wood is to be put, and the urgency of the demand ; for instance, walnut used merely for panelling can be exposed to much more rapid and drastic seasoning at high temperatures than if it be intended for use in the propellers of aeroplanes.

Such investigations will certainly repay the expenditure of time and money, not alone in the resultant saving of time but also in the economy of timber. As regards the former, the time of seasoning is reduced from years to months, and from months to days, or, for certain purposes, to hours. While, as regards economy of timber, Tiemann calculates that in the United States the losses of timber due to natural seasoning are five and more than twelve per cent respectively in softwoods and hardwoods, and that these can be reduced to 2 per cent. In view of the fact that in certain types of kiln drying waste steam may be used, the economic significance of these facts is doubly clear.

One method of introducing heat and moisture into a kiln is to supply steam. Drastic steaming at high temperatures permanently weakens wood, even if it be relatively brief. On the other hand, prolonged steaming or "stewing" of wood in a confined space improves the qualities of woods in certain directions, in that it

decreases their tendencies to warp and sometimes renders them more decorative by changing their colours; for instance, beech is thus induced to become somewhat mahogany-like in tint and in resistance to working. This off-shoot of artificial seasoning provides an additional line of inquiry leading to the improvement in the qualities of inferior woods, especially from our tropical Colonies.

The seasoning of wood has yet one more important bearing on the economy of timber: it increases the resistance to decay. Decay or rot, in at least the overwhelming majority of cases, is caused by wood-destroying fungi, which demand for their development a certain amount of water.

The protection of wood from decay is a matter of great national importance. In our shallow and damp coal-mines, where the air is warm and moist, wood-destroying fungi are often so abundant and so active that timber is rendered useless in a few weeks or months. In 1913 the value of the imports of pit-timber into this country was nearly £4½ million sterling. An American investigator calculated that in the United States, if 40 per cent. of the pitwood were treated with antiseptics the annual saving in that country would be more than 50 million cubic feet of timber. I myself have seen a coal-mine in which the untreated pit-props had to be replaced in four to twelve weeks; whereas creosoted props side by side with them had already lasted for eight years. The neglect of adequate protection of wood from decay in this country is emphasized by the fact that I can secure no approximate estimates of the loss in pits, in buildings, fences and posts, or ships. The resultant loss must amount to millions of pounds annually, and much of that loss could be economically prevented.

Two methods, namely, sanitation and antisepsis, offer themselves as means of decreasing or preventing the decay of wood.

As in pathological problems generally, and especially in epidemics, sanitation is in the end the cheapest method; but it demands a knowledge of the life-histories and conditions of activity of the organisms doing the damage. A few facts and

examples may serve to illustrate the type of research that is urgently called for.

Fungi, which spread by means of their threads or microscopic spores, can be found growing in any house or damp coal-mine. Some of these are practically harmless, others actively destroy wood; it is therefore necessary to identify the fungi present, and to investigate their action in wood.

After that the first practical problem in sanitation is to determine the source of the noxious forms, which may come from the forest, timber-yards, builders' yards, ships, or coal mines, or elsewhere. The neglect of the elements of sanitation may be noted in builders' yards, where infected wood removed from houses is stored side by side with fresh timber and sometimes ready for incorporation into a new building. In a very large timber yard in London I have seen the fructifications and spawn of the most virulent dry-rot fungus lying almost in contact with immense stacks of softwoods.

The fungi responsible for dry rot and decay generally vary in their demands for moisture. Some demand quite moist wood, and can readily be exterminated by ventilation and protection of the wood from wet; yet a few species, when once established, can manufacture water and thereby attack the driest wood. Some are readily killed by heat, and cannot thrive at relatively high temperatures, others are more resistant to heat.

Again, certain species send their threads into the wood and spread internally at a slow pace, keeping at a distance from the surface. Cases due to this type of fungus are easily dealt with by removing the attacked piece of wood. Whereas other species not only penetrate the wood, but produce sheets or cords that rapidly swoop over the surface of the wood, grow over and penetrate walls and so transmit the infection through a complete building or roadway in a coal-pit

Some species can attack only one kind or class of timbers, so that sanitation may take the form of avoiding the use of these. Other species can destroy woods varying from pine to oak and even teak.

This last consideration brings forward the question of the natural durability of timbers, upon which experiments are essential from the direct practical point of view, and because the investigation of the relative immunity of certain species may afford a clue to a cheap and simple method of increasing the durability of woods that normally possess little.

As an accessory to or a substitute for sanitation, timber may be protected by the use of antiseptics such as zinc chloride, creosote and its derivatives, and various other inorganic and organic substances. These differ from one another in their fungicidal efficiency, some being completely effective against all fungi, others being (in practicable concentrations) lethal only to certain kinds of fungi. Moreover, the durability conferred depends upon the depth to which the antiseptic penetrates. Hence the precise process (whether painting or injection under pressure) and the precise fungicide to be used will depend partly upon the length of time that the timber has to last. These will also depend upon the situation of the timber; creosote with its powerful scent and discolouring qualities cannot be used in dwellings; whereas zinc chloride is not eminently suited for superficial coatings out in the open as it readily washes off. The discovery of cheap antiseptics suitable for various situations is a line of research of such fundamental importance as to be worthy of patient chemical and mycological investigation.

Just as the antiseptic treatment of wood renders possible the replacement of valuable durable timbers by cheap perishable ones, so likewise does the *fire-proofing* of wood subserve economy by permitting thin pieces of inferior wood to be substituted for thick pieces of more costly wood; specifications demanding that the doors of buildings shall be made of teak of great thickness are, therefore, extravagant, even though decorative. Investigations have rendered possible the fire-proofing of wood to such an extent that even thin three-ply can be made to resist for minutes or hours a temperature of 3000° Fahrenheit. The process of satisfactory fire-proofing is, however, not a cheap one, as the cheaper substances used are apt to wash out, to attack metals and even

favour the development of decay-inducing fungi. A problem of vital importance to builders, and even to the Empire, is the discovery of a cheap solution that shall simultaneously protect wood against decay and fire, and shall be suitable for use in dwellings.

Another method of improving woods, and especially those of inferior quality, is that of changing their colours and thereby improving their decorative value. By this means unmarketable Colonial woods may be rendered of use. Such changes may be induced by steam, by chemical treatment with vapours or solutions, by treatment with dyes, or finally by exposing the wood to the action of fungi or bacteria. Except as regards the production of fumed oak by ammonia vapour, this branch of industry has been neglected in this country, which imports such stained woods as grey sycamore, artificial ebony (for piano-keys, knife-handles, and so forth). As an illustrative case, reference may be made to grey sycamore, which is obtained from ordinary white sycamore by means of simple and cheap chemical treatment. Yet for years white sycamore was exported to Paris and Hamburg for treatment, and reimported into England at an increase of price perhaps fifty times the true cost of the process. Great Britain does, however, export one unique type of coloured wood, brown oak, which, owing to its richness of tint, is much more valuable than the ordinary British oak. At the Imperial College it was discovered that the brown colour is induced by a fungus, and that by growing the latter upon ordinary oak this is converted into the brown wood. It would doubtless be possible to devise a method by which this exceedingly profitable conversion could be conducted on a commercial scale.

The chemical utilization of wood forms too wide a subject to be dealt with except by allusion. As a means of using up waste wood (sawdust, shavings, slabs) in the saw-mill, or waste trees in forests of the Colonies, mention may be made of the *destructive distillation of wood*, which thus becomes a source of methyl alcohol, formalin, acetic acid, acetone, and charcoal. In countries having feeble supplies of coal this same process can be made to

yield illumination and power. Other problems concern the most economical manner of using waste wood directly as a fuel.

In connection with several lines of investigation, mention has been made of the utilization of waste wood, and in order to illustrate the fact that this alone represents a problem of national importance, I will mention that in this country there is one single wood-using establishment in which the normal annual loss or wastage of timber represents a sum approaching £20,000.

For the purpose of demonstrating what the British Empire has done and is doing in the way of forwarding technical knowledge relating to timbers, I will compare its activities with those of two other great Powers, the United States and Germany.

Although France produced the first model investigations on the mechanical properties of wood, Germany *in recent times has* done a large volume of excellent work and correlated the results with the structure of timbers concerned. Along the two lines it has been ably seconded by Austria, and these two partners have conducted minute and detailed research on timber-structure from the point of view of identification. To Germany more than any other country we owe our modern knowledge on the fungi inducing decay in timber, and on modern antiseptics suited for combating them. Germany together with Austria, has largely contributed to the development of the technical art of changing the colours of woods by chemical means and by dyes. Her work on the utilization of wood as a fibre material, as fuel, and by destructive distillation, has given to her the leading place in these fields.

Germany has, in addition to her forestry schools, various institutes from which emanate the results of researches in the various branches of the subject And the State has founded, staffed and equipped an institution whose sole function is to investigate the problems of the decay of timber and its prevention.

Germany thus spends thousands of pounds annually on timber investigation. She also promotes the use of her Colonial timbers by this means, and by describing or referring to them even in small text-books.

The United States has produced many valuable results on the mechanical properties of North American timbers, and on technico-practical questions concerning American woods as sources of fibres and of chemical bodies. Her workers have also published much detailed original information on the structure and identification of the indigenous timbers. While in one branch, that of artificial seasoning of wood in kilns, the United States leads the world in original investigation and practical invention.

Apart from possessing some forestry schools, the United States has one institution specially founded for the investigation of timber problems, namely, the Forest Products Laboratory, at Madison. I believe that the annual sum paid for researches in this laboratory exceeds £40,000. This laboratory works in close touch with men engaged in the timber trade. And the timber trade journals published in the United States give, by the very nature of their articles, sufficiently clear evidence of the intimacy of the relations between wood industries and technical science.

Great Britain doubtless was handicapped by the lack of any great forests that should stimulate research of the highest type on the mechanical qualities of timbers. First-class original work up to modern standard has never been produced in this country on this branch; the work executed has been narrow in scope, because done by engineers who even to-day are profoundly ignorant of the basic facts on the subject of wood-structure. The sole comprehensive modern researches on the mechanical properties of wood conducted in the British Empire emanate from Australia. In regard to the structure of timber this country has contributed little, except fragments concerning Colonial woods. But in India Mr. Gamble has produced a great work on the macroscopic structure of Indian woods. Although England at the outset led the way in providing antiseptics and means of injecting them into timbers, her original scientific activity in this direction ceased decades ago; while as regards the investigation of the fungi causing decay in timber, our Empire has done practically nothing.

Altogether, famous as this country has been in the past from the practical stand-point as regards timber, she has been a non

entity as regards the scientific technology of wood. The time has passed when it is safe to continue such a policy.

In the United Kingdom, although there are some incipient schools of forestry, and there is a professor of the technology of woods at the Imperial College, the State neither maintains any technical authority on timber in its employ nor devotes any sum to research on the subject. The timber industries likewise have no technical consultants, nor do they subsidize research. Hence, where the Governments of the United States and Germany spend annually thousands of pounds on timber research conducted by specialists, our Government spends not a penny, though the wood imports amount in value to more than forty million pounds sterling annually. The Forest Research Institute in India and Forest Products Laboratory in Canada represent the official provision made by the British Empire for the investigations on woods coming from forests that are larger in extent and variety than those governed by any other State in the world, and that represent a value of hundreds of millions of pounds.

But there are signs of awakening as regards research. The awakening is Imperial, not merely national; and this is of vital importance because this country and the remainder of the British Empire should be linked together in policy as regards the great timber problems of the future, and therefore linked together in attacking the problems whose solutions will dictate that policy and will indicate the best method of utilizing our common timber resources. In this country and in Australia Departments of Scientific and Industrial Research have arisen, and it is to be hoped that the great trades will also take part in this forward movement, for the greatest advances can be achieved solely by the co-operation of the State, the trade, and the technical specialist—and this is especially true of the great timber industry.

In the course of the discussion, Mr. A. L. Howard thought the paper was a sufficient answer to the gentleman who, when Professor Groom last read a paper before the Society, said that scientific research was of no use with regard to timber, and that what was wanted was the advice of practical men who understood

timber. The paper contained a great deal of food for reflection for the practical timber expert. With regard to the quality of the timber grown in England, until the previous autumn he did not know that timber grown in the south of England was not only as good as but considerably better than some timber imported from the Baltic He had seen Scots pine grown in the south of England which, in freedom from knots and sap, was superior to a great proportion of the timber that had come from the Baltic. In that connection he might mention that, whereas the price allowed to be paid for the foreign article at the present time approached 8*s* per foot cube, the price which was allowed to be paid for the British-grown product, whether it was of the highest possible quality or of the lowest possible quality did not reach 4*s*., or half that of the foreign article He thought that was a continuation of the policy adopted in the past, which had led to the deplorable results witnessed at the present day. Twenty years ago the Arboricultural Society appointed a Rates Committee, of which he was a member, and he found that Germany carried foreign timber inside her borders at a rate which was many times greater per foot than the rate at which she carried her home-grown product. Germany also gave a premium to everybody who would use the home-grown product, and she made it difficult to use the foreign product. The Committee found that in England it cost as much to bring timber from Liverpool to London by rail as it cost to bring it from a thousand miles in the interior of America and across the Atlantic into London. The second point in the paper which he thought was particularly worthy of remark was the number of tests which Germany had made in regard to the quality of timber. He assumed that the author's remarks in that connection applied only to Scots pine, because in this country we knew the mechanical values of many of our timbers other than the Scots pine. With regard to the question of the name of the timber imported from the West Coast of Africa and sold under the name of "mahogany," and the harm that has been done to this country and the benefit that had ensued to Germany thereby, he did not think the author's explanation was quite correct. He was afraid the real reason why

the wrong names were given to timbers was because of the want of scientific research and knowledge, and of any attempt to bring to the front the proper way of dealing with woods and their names, and because of the looseness of our laws in connection with the matter. For instance, for many years past large quantities of so called Austrian oak had been supplied in this country which consisted of other kinds of oak, and yet the timber had been accepted and used. Then again, certain teak was called "Borneo teak," although he thought it was a fact that there was not and never had been any teak in Borneo. While teak possessed an essential oil which was preservative to itself and to everything with which it came into contact, the wood which was called teak and sold as teak, possessed an essential oil which was harmful to itself and to everything with which it came into contact. The same point applied in connection with many other woods. For instance, it had been found impossible to sell the sweet gum of America under the name of "gum," and it had been called successively satin walnut, hazel pine, and Californian gum. The mixing of woods was generally to be traced to tradesmen, who gained a benefit by so doing, and there were apparently no laws or societies or associations to protect the users. With regard to the question of sending timber to be coloured in Paris and Hamburg, the British public would not buy coloured woods very readily; the demand for them in this country was very limited and uncertain, and it was therefore not worth while establishing plant to any extent. The cost of freight to and from Paris was very small, and the process of dyeing adopted there was very beautifully performed. If there had been a greater demand in this country for coloured woods, no doubt that demand would have been met by the establishment of plant on a larger scale. He did not agree with the author's remarks about the economy practised by this country in the use of timber, because he thought we were the most extravagant people in the use of timber that the world had ever seen. If a comparison was to be made of the consumption of wood in different countries, the varying circumstances and necessities of those countries must be taken into

account. For instance, the population of the United States as compared with its area was very different from that of Great Britain, and many farmers in America and Canada built their houses of wood. A comparison could not be fairly made between the amount of timber such men required and the amount needed by men living in brick houses in London The extravagance in the use of timber in England, especially since the war began, was positively criminal, and he was afraid the Government was the greatest offender. A contract had recently put out by the Government for field telegraph poles about 8 feet or 12 feet long and 1½ or 1¾ inch in diameter, and the contract provided that a sum of about £7,000 should be expended on Oregon pine at something exceeding 8*s*. per foot cube for those poles. Before the war clean, straight-grained Oregon pine could be obtained for about 1*s*. 6*d*. or 1*s*. 10*d*. a foot, and then, perhaps, it was the best timber that could be used, but why should 8*s*. per foot cube be paid now for Oregon pine for field telegraph poles when those poles could be just as well made of white spruce or Scots pine or larch, for which the Government would not allow anyone to pay more than 10*d*. per foot? It must also be remembered that Oregon pine at 8*s*. per foot cube was of doubtful quality, because if that was not so, it would have been worth 24*s*. per foot cube for aeroplane work. Then, again, he had seen maul-heads made of beautiful timber brought from abroad at a cost of about 12*s*. or 14*s*. per ft. cube, when British elm would have done perfectly well. Lastly, what about the policy of a Government that established an enormous Timber Department for the purpose of economy im supplying timber? Such a department might be necessary, but it certainly was not economical. He did not think any Government department in this country was ever carried on on economical lines.

Mr. William Woodward, F.R.I.B.A., remarked that as an architect he was, of course, much interested in the use of timber. He did not know if Professor Groom could tell him why there was a very obnoxious smell from certain teak, because he knew an instance where a City office was fitted up with teak at very

great expense, and the result of the perfume was such that the teak had to be removed. Architects had for many years past been in the habit of using Austrian oak because they knew that unfortunately they could not use English oak for ornamental purposes.

The Earl of Powis said he should very much like to know what Mr. Woodward meant by his statement that it was impossible to use British oak for ornamental purposes. His own impression of British oak as compared with Austrian oak was that if he was going to use oak for ornamental purposes he certainly should specify British oak. He knew that a great many architects had for many years been very much opposed to the use of British timber, and had specified that foreign timber should be used. But he thought that had been to a great extent owing to the difficulty of getting exactly the quality of timber that they wanted at the moment, not that it was not growing in the country. His own feeling was that we ought to encourage British timber a great deal more than we did, and architects were the people who could do that a great deal. May I say one word more as to my own experience of panelling? In my own house, where the late Mr. Bodley, the architect, specified for British oak and nothing but fifteen-year-old timber—timber that had been seasoned for fifteen years—was used, I may say of the panelling that was put up for me that not one single crack has come in that British oak.

Dr. Groom cordially agreed with the Earl of Powis as to the decorative quality of British oak, and its superiority over every other type of oak from a decorative point of view. Of course, one would admit straight off that it was harder to work, and having a more curled grain it was more liable to split. He thought the panelling in the Court of Criminal Appeal, which was made of British oak, was the finest model of panelling one could see.—[*Timber Trades Journal.*]

BRITISH SCHEME OF FORESTRY.

The Forestry Sub-Committee of the Reconstruction Committee has recently issued a full Report on the subject entrusted to it. As might have been expected, the lessons of the war have been taken to heart and a strong recommendation is made to promote home forestry to the fullest extent possible. It is recognized that such a war may possibly occur again and the country not be in so favourable a position as it has been this time in obtaining timber supplies from abroad. Great Britain even before the war, was the poorest timbered country in Europe, during the war she has made severe demands on her own supplies, and after the war she well be left with greatly reduced resources. The quantity of timber required for direct war purposes has exceeded all calculation, and the difficulty of importing it with a scarcity of ships has been enormous, and so has the cost. The remarkable thing is that all the timber demanded for war purposes is of a kind that could have been grown on British soil, and that there is sufficient waste land to have grown it on had such land been so utilized. To put it shortly, the country has taken as much risk with its timber supplies as with its grain supplies, and the Sub-Committee with much force points out that such risks should not be taken again. The scheme of national afforestation recommended will, it is believed, secure a great many advantages. Without encroaching on land suitable for crop cultivation, there are between 4 and 5 million acres of land fit for growing timber of the same class and quality as has been imported; and if only half this land were now afforested, in 40 or 50 years hence the country would to a great extent be independent in the matter of timber for both military and commercial purposes. The result of such a policy would be the retention at home of money now and spent abroad, and the establishment of a valuable home industry There would also result the profitable development of large areas of land now left almost wholly waste. The rural population would be increased and would find employment alternatively on forestry and on agriculture where now it is not sufficient to meet the urgent demands of agriculture at certain times And, of course, it need not be emphasized that England is

the present rate of consumption. The total cost for the first 40 years may be £15 millions sterling. After that the scheme should be self-supporting. The whole sum involved is therefore less than half the direct loss incurred during the years 1915 and 1916 through dependence on imported timber The rate of planting could, of course, be very much speeded up were a very large number of demobilized men put on the scheme. The proposal is to plant at least 150,000 out of the first 250 000 acres by direct State agency and the remaining 100,000 by local bodies and private owners with State assistance and control. For controlling the scheme it is proposed to create a Forestry Commission represented by a Parliamentary Commissioner in the House of Commons who would answer for the Department and practically be its Minister. The Commission would comprise six members, three of whom would be whole-time salaried officials and three would be unpaid. Consultative committees would also be formed separately for England, Wales, Scotland and Ireland. It is estimated that the service would require 60 officers by the fifth year of operation. The men would have to be university trained with an honours degree in science. Under them would be foresters and foremen trained in forestry schools after leaving the secondary or continuation schools at the age of 18 or 19 This Forestry Commission it is recommended, should control Forestry education and should maintain demonstration woods for practical work.

It appears to us that the modest cost of the scheme has not so far been realized, otherwise a national development of so far-reaching an order might have been taken up long ago. It is something to know, now that the whole subject has been properly examined, that for the comparatively trifling sum of fifteen million pounds the reafforestation of the British Isles can be accomplished and a national industry created which would keep 125,000 persons on the soil.—[*Indian Engineering.*]

at the present day feeling the effects of a greatly diminished rural population by a general crowding into centres of industry where the physical fibre of the people unquestionably becomes reduced.

It is recommended that forestry be made a State industry because experience in the past has shown it to be an unpopular form of investment for private capital on account of the great delay in realizing returns. There are such large and profitable investments offering in the many industries starting up at the present day that little capital would be forthcoming for forestry apart from what the State chose to devote to it. The State is therefore recommended to undertake a scheme on a scale that would in an emergency keep it independent of imported timber for three years on a present day war basis of consumption. The total cost for the first ten years would be about £3½ millions allowing not only for the direct cost of afforestation but for all incidental charges for administration, education, research, etc. If we compare this sum with what timber has cost the nation during the war its trifling nature will be evident. During 1915 and 1916 alone we paid £37 millions more than its pre-war value for the timber imported. Moreover, at a time when every ton of shipping was priceless these imports absorbed 7 million net tons, equivalent approximately to 14 million tons dead weight. Just before this time the proportion got from the Empire had fallen from 22 per cent. in 1899 to 10 per cent. in 1913. Were the areas now devoted to rough grazing devoted to timber growing the very best classes of timber could be produced, while the decrease in the production of meat would not be more than 0·7 per cent. and the number of people to whom employment could be given would be ten times that employed in grazing.

It is proposed to afforest 1,770,000 acres. Taking 80 years as the average rotation, two-thirds of the whole should be planted in the first 40 years. From the fifteenth year onwards the scheme would begin to provide pitwood from the quicker-growing species on the better kinds of mountain land. By the fortieth year the plantations made in the first ten years alone would contain enough timber to keep our pits supplied in emergency for two years at

LIGHT CHIR TAR OIL.

We are indebted to Mr. C. E. C. Cox, Officer-in-charge Forest Chemist's Office, Dehra Dun, for the following Note by Mr. T. P. Ghose on the analysis of Light Oil obtained as a bye-product in the distillation of Chir Stump wood for Stockholm Tar :—

CHARACTERISTICS OF THE OIL.

A sample of the light tarry oil obtained as a bye-product in the distillation of Chir *(Pinus longifolia)* stump wood for Stockholm tar was received from Almora through the Forest Economist for examination. It was a viscous oily mass quite transparent in thin layers and possessing the following characteristics :—

Colour ...	Yellowish brown in a thin and dark brown in thick layer.
Reaction ...	Acid.
Solubility ..	Completely miscible in alcoho .
Specific gravity ...	1·002 at 30°C.

Fractions—

Loss at 100°C. ...		4·0 per cent.	
Fraction between..	100°—200°C.	21·1 per cent.	43·5 per cent light oil.
	200°—250°C.	22·4 per cent.	
	250°—310°C.	28·5 per cent.	heavy oil.
Pitch)by difference)	...	24·0 per cent.	soft and slightly sticky black

From the above it will be seen that this light tar is very rich in light oils. The percentage of water and pyroligneous acid is low as it should be and shows that the tar oil has settled properly.

The light oils which contain the greater proportion of wood creosote were first washed with dilute sodium carbonate to remove acetic acid, etc., and then treated with a 5 per cent.

caustic soda solution. As a result the following percentages of phenolic bodies were obtained :—

Total crude phenolic bodies present in the fraction passing between 100—200°C.	11·24 per cent.
Total phenolic bodies present in the fraction passing between 200—250°C.	18·64 per cent.

The heavy oil was also treated as above to estimate the percentage of tarry acids. In this case however, some indifferent oils were also dissolved out by caustic soda. These were removed by diluting the caustic soda solution with water and keeping it exposed to the action of air—whereby they were thrown out of solution and were removed by filtration. The above operation was repeated twice, and the tarry acids finally obtained were weighed.

Total crude phenolic body in the fraction between 250—310°C. ...	13·8 per cent.

Hence the phenolic bodies calculated on the tar itself amount to 10·48 per cent.

Wood Creosote from the Tar.

The crude creosote obtained from the light oils (*i.e.*, fractions between 100°—250°C.) was further purified. The creosote which was still dark was fractionated with the following results :—

Fraction up to 105°C.	4·3 per cent
" between 105—200°C. ...	4·3 "
" " 200—250°C. ...	84·5 "
Residue	6·9 "

The fraction up to 105°C. represents water dissolved in the creosote and fraction between 105—200°C. represents phenolic bodies such as 'Phenol,' 'Cresol,' etc. The fraction between 200—250°C. consists mainly of 'Guaiacol' and 'Creosole' and higher homologues Hence it will be seen that the creosote obtainable from this tar is fairly rich in 'Guaiacol' and Creosole,' etc. This fraction had a specific gravity of 1·0645 at 30°C.

When the above fraction was treated with cold saturated alcoholic potash it solidified at once. Pure creosote was regenerated from this solid magma and again *fractionated to determine the* proportion between 'Guaiacol' and 'Creosole' and the higher homologues.

Fraction between	100—120°C.	...	6·6	per cent.
" "	120—200°C.	...	21·1	"
" "	200—208°C.	...	8·0	"
" "	208—230°C.	..	42·1	"
" "	230—255°C.	...	17·1	"
Residue ...	...	...	5·1	"

As the fraction between 200—206°C. represents 'Guaiacol' it will be seen that this Creosote is richer in 'Creosole' (which comes in the fraction between 206—220°C.) than in 'Guaiacol.' The fraction between 200—230°C. had a specific gravity of 1·069 at 30°C. which is slightly lower than the B. P. limit, otherwise it conformed to all other B. P. tests. An alcoholic solution of this fraction when shaken with cold barium hydroxide solution did not develop any *blue, violet or red colour, showing the absence* of all objectionable impurities. With ferric chloride solution it developed a green colour, which changed to reddish brown on standing. Only a portion of *creosole* has to be rejected from this fraction to make the specific gravity rise to 1·079, which is the B. P. limit. Hence it is quite possible to prepare an officinal quality of wood creosote, or if desired some quantity of Guaiacol from this tar and it may be found possible to utilize it for this purpose.

LIGHT TAR OILS.

The light tar oils, that is (*i*) the fraction passing below 200°C. and (*ii*) the fraction passing between 200°C.—250°C. were separately treated with alcoholic potash to remove other estrified bodies, and the hydrocarbons were then rectified. These two oils had the following characteristics :—

1 Light oil (passing up to 200°C. rectified) specific gravity at 30°C.	...	0·873
Refractive index at 30°C.	...	1·4790
Angle of rotation in 10 c m. tube	...	10°—15′

with water and thus can easily be spread over a large surface. To prepare the disinfectant the following recipe may be used :—

Sodium Carbonate	..	...	14 parts.
Water	...	...	...	200 „
Rosin	...	...	...	100 „
Tar Oil	...	...	...	75 „

The tar oil which contains some pyroligneous acid should be first neutralized with sodium carbonate solution. As soon as all the rosin has been added to the sodium carbonate solution and the soap is nearly ready the neutralized tar oil is added. The whole may then be boiled till the mixture reaches the proper consistency and then set apart.

SUMMARY OF RESULTS.

From the above it is evident that this tar, if properly worked, can be utilized for the preparation of the following products :—

1. An officinal quality of wood tar creosote can be obtained. If desired some quantity of pure guaiacol can also be prepared from it.
2. The light oils if properly worked can be used as a substitute for turpentine and solvent wood tar naphtha can also be prepared for use in the rubber industry.
3. The heavy oils can be used as a lubricant for engines.
4. The tar itself can be used along with rosin soap for the preparation of a disinfectant.—[*Indian Trade Journal.*]

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THE REGENERATION OF SAL (*SHOREA ROBUSTA*) FORESTS.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

The long series of experiments which has been carried out at Dehra Dun in recent years, it is believed, justify the following conclusions. A detailed account of the experiments on which these conclusions are based will shortly be published in the *Indian Forest Records*. These conclusions, it is suggested, indicate a combination of the group and strip systems to be the best method of securing the regeneration of the type of sal forest here dealt with. A sketch of the proposed system is also given below :—

I.—SUMMARY OF CONCLUSIONS BASED ON THE RESULTS OF EXPERIMENTS.

1. Sal seed is particularly liable to damage from drought. If, however, care is taken to keep it cool and to prevent it drying out, it can be kept for some weeks without injury. The writer has sent sal seed from Dehra Dun to Singapore which was 24 days in transit and which produced a good stock of healthy seedlings on arrival.

2. The results previously obtained by Mr. R. S. Troup and the present writer regarding the injurious effect of a soil covering of dead leaves on germination and the early growth of sal seedlings have been confirmed and it has been shown that the action is hreefold.

(*a*) A drought action, owing to the dry barrier separating the seed from the soil surface, which causes the death of the seed either before or shortly after germination has commenced.

(*b*) A mechanical action due to the obstruction afforded by the tough leaves to the passage of the radicle. When moisture and temperature, therefore, are suitable for the continued growth of the radicle, the latter instead of penetrating vertically downwards into the soil develops horizontally between the layers of leaves. In consequence of this the plants die from drought so soon as the dead leaves and surface soil dry out.

(*c*) An injurious action which comes into play after the radicle has penetrated the soil and which is provisionally ascribed to bad soil-aeration. It directly causes an appreciable number of deaths and also increases subsequent damage by drought by diminishing root growth. It is active in sal forest loam which is kept moist but is inoperative in clean sand. How long this action is capable of retarding growth remains to be determined by further work. It is possible that it is chiefly injurious to young seedlings which have their delicate young roots in or near the surface soil.

3. Burning off the layer of dead sal leaves in the forest does greatly improve germination and increases the number of seedlings which survive.

While not materially diminishing the number of seedlings which were on the ground before the burning, the latter appears to reduce the height growth of such seedlings.

4. Removing dead leaves by burning and encouraging germination in the shade with a view to opening the cover later, while useful as a supplementary measure, gives too poor results to allow of its being accepted as a main system of regeneration. Either a long period must be allowed for the production of a full stock of seedlings in the shade with an average height of about 3½ ft. (probably at least 48 years), so that they may be strong enough to survive the exposure caused by removing the cover and to establish themselves without the aid of weeding operations, or else after removing the cover the seedlings must be assisted by hoeing the soil and weeding, in which case it is obviously advisable to supplement the work by artificial sowings, in order to gain the full advantage of this extra expenditure and to make a certainty of good results. Instead of wasting time, therefore, in preparatory work, it is probably advisable to commence at once with hoeing and artificial sowing in clearings. In the system proposed in the present paper the latter procedure is advocated.

5. Complete removal of the overhead cover gives results decidedly better than those obtained by merely interrupting the overhead cover. Under the latter system, although possibly a greater quantity of seed does fall on the area, this is discounted by the large proportion of seed which fails to germinate and of seedlings which fail to survive under the cover of the trees. Moreover, owing to the uncertainty of good seed years, no successful system of regeneration can rely entirely on natural seed. While no doubt, in a given time, less weed establishes itself where shade trees are left, it must be remembered that the weed growth is usually strongest where the seedlings chiefly survive, *i.e.*, where there is least shade, and that, owing to the less vigorous growth of the seedlings, weeding must be carried out for a longer period in such cases than is necessary on areas which are completely cleared. Again, under this system, a considerable portion of the area under the shade of the trees must eventually be sown up artificially and considerable damage is likely to be done to the young growth when the shade trees are finally felled.

6. Experimental sowings carried out in 1915, 1916, 1917 and 1918 have fully corroborated the results previously obtained in 1912 and 1913 and have shown that very much better results are invariably obtained, both in favourable and unfavourable seasons, from sowings in cleared patches and narrow strips with full overhead light than from sowings under shade.

7. The diameter of the patches and width of the strips should not exceed the height of the adjacent trees. The larger the patches and the wider the strips the stronger is the resulting growth of weeds and the greater the damage to the seedings by drought. On the whole, the best width for the strips and for the diameter of the patches is three-fourths the average height of the adjoining trees. In openings of this kind frost does no damage. In order to diminish trouble from weed growth it is desirable to regenerate small cleared patches first and then to gradually extend these areas in the form of narrow strips.

8. In the smaller clearings two weedings will probably be sufficient, one at the end of the first rains and one at the end of the second rains. In the larger clearings four weedings will probably be required, one at the end of the first rains, one at the beginning and end of the next rains and one during the next two years.

Weeding should be done with discrimination and in the larger clearings scattered plants of the large tufted grasses (*Saccharum*, *Erianthus*, etc.) or a few woody coppice shoots (which can be topped when necessary) are often beneficial in decreasing water-loss from the plants and in preventing the development of the highly injurious matted growth of small herbaceous plants.

9. In some cases, where the ground is fairly level and the soil surface has not been hardened, quite good results may be obtained from sowing on undug soil. When on loam the ground is not level, the seed is quickly washed away by the rains, whereas in dug soil the rainfall percolates *in situ*, an equable distribution of moisture in the soil is secured, the seeds are not washed away and a well distributed stocking with vigorous plants is

secured. To obtain uniformly good results, therefore, hoeing is necessary.

10. As a considerable percentage of seed inevitably fails to germinate in broadcast sowings and as burying the seed in the surface soil would probably be too costly, it is essential to sow thickly, *e.g.*, at a rate of not less than six seeds per square foot of area, which will insure a fairly full stock of seedlings even in an unfavourable season

11. In the moist forests in which these experiments have been carried out, in a year of normal heavy rainfall (60 *inches* and above during the period June to September inclusive), side shade from the south is decidedly injurious by keeping the soil perpetually moist which causes the plants to suffer from a badly aerated soil and from the attacks of leaf fungi. Bad results are also obtained in areas which receive no side shade from the east, west, or south, a large number of plants dying in such places from drought in the dry season. On the other hand, uniformly good results are obtained in areas which receive a considerable amount of side shade both in the morning from the east and in the afternoon from the west. In moist forests, therefore, the shade from the south side of patches should be diminished and the strips should run in a north-south direction. This insures shade on the area during the morning and afternoon, with full sunlight during mid-day which prevents excessive dampness of the soil.

It is probable that equally good results would be obtained on strips running from north-east to south-west, this direction also affording more or less side shade from the east and west, together with exposure to the hot afternoon sun.

On the other hand, in dry forests, where comparatively little damage is done by bad soil-aeration and where the seedlings suffer chiefly from drought in the dry season, side shade from the south may be beneficial and it is probable that an east-west or south-east to north-west direction would be best for the strips, as this would afford the maximum shade from the hot mid-day or afternoon sun.

12. The greatly superior results obtained in the cleared patches and strips, as compared with those obtained under shade, are mainly due to two factors :—

(*a*) Improved soil-aeration and consequently stronger root growth during the rains, owing to the partial drying out of the soil in the clearings during the intervals of hot sunshine.

(*b*) Moister soil in the clearings during the cold and dry season. This is caused by the addition of water to the soil in the form of heavy dew and light showers while water-loss by evaporation and transpiration is retarded by the side shade afforded by the adjoining trees. Very little dew or light rain reaches the soil under the shade of trees which, during this period, remains much drier than that of the clearings. This increased moistness of the soil improves germination and helps the plants to withstand the hot dry season.

These results, therefore, have corroborated the previous conclusions that the two factors of outstanding importance which affect the healthy development of sal seedlings in this locality are bad soil-aeration* and drought. (*Ind. For. Rec.* V, 4, Part II, p. 77, 1916). //

13. The average annual height growth of sal seedlings which can be obtained in the locality under various conditions is shown below, as calculated for the first five years from the measurements of seedlings of known age :—

Conditions	Average annual height growth in inches.
1. Practically ideal conditions of moisture, light, soil and absence of weed competition in the Dehra Dun Experimental Garden	32
2. On a small scale in the forests in cleared patches in an unusually favourable season	10
3. On a comparatively large scale by broadcast sowing on hoed soil in the forests on cleared strips in an average season ...	8·6
4. Under shade in the local forests	1·5

* In a letter to the writer, dated 28th August 1917, Singapore Botanic Gardens, Mr. I. H. Burkill writes as follows :—" We are having very wet weather and it shows how your observations on the need of soil-aeration can be extended from *Shorea robusta* to *S. macroptera* and *S. rigida*, for there is a great mortality proceeding among last year's seedlings in the Gardens Jungle."

14. In devising a system of regeneration it is necessary to consider not only the rate of growth of established seedlings but also the period required to obtain a full stock of seedlings. It is believed that sal seedlings cannot be regarded as safe from weeds until they have an average height of 3½ feet and it is estimated that under the system of natural regeneration under shade, supplemented by clearing the soil of dead leaves, a full stock of seedlings of this height cannot be obtained in less than 48 years. Thus, allowing for the time required for the removal of the shade trees, certainly not less than 50 years will be required for regeneration under this system. On the other hand, it is believed that the experiments which have been carried out at Dehra Dun justify the conclusion that, under the system of artificial sowing in narrow cleared strips, a complete stock of seedlings 3½ feet high can be obtained in five years.

As a suitable organization of labour to deal with large areas, however, will require time, it is proposed at first to reduce the area to be dealt with annually and to extend the regeneration period to 15 years, this being divided into three sub-periods each of five years.

Under the system advocated in this paper, therefore, it is believed that the regeneration period will be shortened by not less than 35 years.

It is believed that the conclusions which have been summarized above indicate a modified combination of the group and strip systems to be the best method of securing the regeneration of the type of sal forest here dealt with.

II.—Possible Objections to the Proposed System.

Before dealing with the possible objections which may be raised to the introduction of the system now proposed, it must in the first place be clearly understood that this system is not intended to apply to :—

(1) Semi-ruined areas, poorly stocked and with little or no undergrowth except a heavy growth of grass. Such areas are exceptional and require special treatment.

(2) Forests where ample soil moisture is available by percolation or springs and where, owing to the sandy or gravelly nature of the soil, bad soil-aeration is not a factor of importance. In such localities sal seedlings can be established successfully and fairly quickly under shade and regeneration consequently presents no difficulty.

(3) Forests exposed to particularly favourable climatic conditions where there is no fear of frost damage. In such cases sal can be safely raised in the open on large clearings, *e.g.*, in Assam and the Bengal Duars.

The system now proposed is intended to apply to the average fairly well stocked sal forest on loam, in places where frost damage is to be feared, where the dying back of seedlings is a marked characteristic and where the establishment of vigorous seedling growth is at present a slow and uncertain process, *i.e.*, probably to the bulk of the sal forests in central and northern India. In those forests of this class which are decidedly *dry*, on account of deficient rainfall, high temperature, soil characteristics, configuration of ground or other reasons, the system may require modification and it should not be applied in them until experiments have been carried out in such areas, on a small scale, to compare the results obtained in an average season on north-south strips with those on east-west strips. It is possible that in these dry forests side shade on the south may be an advantage and that an east-west direction would be better for the strips than that of north-south which is advocated in this paper for moist forests.

In the second place it must be borne in mind that the system proposed offers a good prospect of reducing the present regeneration period of these forests by not less than 35 years. If this result could be obtained cheaply and with very little trouble, it is fairly certain that it would have been realized long ago. Consequently we must be prepared to encounter some difficulties and to incur such expenditure as is reasonable in view of the advantages to be obtained. With these preliminary remarks the following possible objections will be shortly considered :—

(*a*) *As most of the young growth now existing in the type of forest here dealt with appears to have originated under*

shade, the best and most natural method of securing regeneration must consist in encouraging the growth of seedlings under shade.

The following considerations, it is believed, dispose of this objection:—

(1) Most of the shade in the existing forests is the result of long fire-protection and was not present when a considerable proportion of the young growth now in evidence first originated.

(2) The Dehra Dun experiments have proved that the growth of sal seedlings in the shade is extremely slow, that a seedling requires not less than 40 years to develop a shoot 5 ft. high in the shade, whereas in cleared patches or strips this height can be attained in 6—7 years. Our object obviously should be not to perpetuate a state of affairs under which the establishment of regeneration is extremely slow and unsatisfactory but to improve upon it as far as possible.

(*b*) *The Dehra Dun experiments are on too small a scale to justify conclusions as to the suitability of the system on a large scale.*

In the first place, all other systems which have been tried on a similar small scale have invariably given inferior results to those yielded by the proposed system. In the second place, until we know enough about the different factors influencing growth to be able to explain correctly the results obtained, work on a large scale is apt to be misleading and to cause waste of time and money. To discover the effect of individual factors on growth much detailed observation work, involving the counting and accurate measuring of large numbers of seedlings is essential and it is impossible to do this satisfactorily on a

large scale. When results can be consistently obtained on a small scale, we only require a suitable organization of labour in order to obtain them on a large scale.

(*c*) ***If the strip system is best why does not sal regeneration establish itself in quantities on fire lines?***

In the first place many fire lines are too wide and others run in the wrong direction.

The Dehra Dun experiments have shown that to get really good results heavy sowing combined with hoeing the soil is necessary. On fire lines the soil is not hoed and clearing the line may, or may not, be done in a good seed year. Again fire lines are cleared throughout in a single operation which encourages the rapid establishment of a heavy growth of weeds which swamps the few seedlings which may start growth during the first few years. After this the exposure, combined with annual burning, hardens the soil and renders it steadily less suitable for germination and early growth. The Dehra Dun experiments, however, have proved that, on a 100 ft. wide, north-east to south-west fire line which has been cleared for eight years, excellent seedling growth can be obtained if the soil is dug and the weeds removed.

(*a*) ***As full seed years do not occur every year it may be impossible to stock an area at once after clearing and heavy weed growth may result.***

A considerable quantity of sal seed is produced annually, and by suitable organization of labour it should be quite possible to collect sufficient of this for the stocking of the annual regeneration area. The Dehra Dun experiments, also, have proved that a 60 ft. wide strip which has been cleared for two years can be successfully stocked by broadcast sowing on hoed soil.

(e) *The system requires more labour than is likely to be available.*

In the sal forests in question labour is, as a rule, difficult to obtain during the rains, but it is believed that the only work that need be done then (in June or early July) is the broadcast sowing which obviously requires very little labour.

Apart from this it will, in any case, probably be necessary to considerably increase the available labour in these forests by establishing forest villages or otherwise, in connection with other work of great importance, such as the afforestation of extensive grasslands.

III.—SYSTEM OF REGENERATION PROPOSED.

The system of regeneration proposed is really a combination of the group and strip systems. Its main features are indicated by the following prescriptions :—

(a) Determine the average height of the forest at maturity, *i.e.*, at the time when it is to be regenerated.

(b) Divide the area permanently into narrow strips running due north and south, the width of the strips to be three-fourths of the average height of the forest. Thus average height 80 ft., width of strip 60 ft.

(c) Only the alternate strips are to be regenerated first, *i.e.*, the regeneration area = half the total area. The remaining strips are not to be regenerated until the young growth on the regenerated strips has attained the original height of the forest.

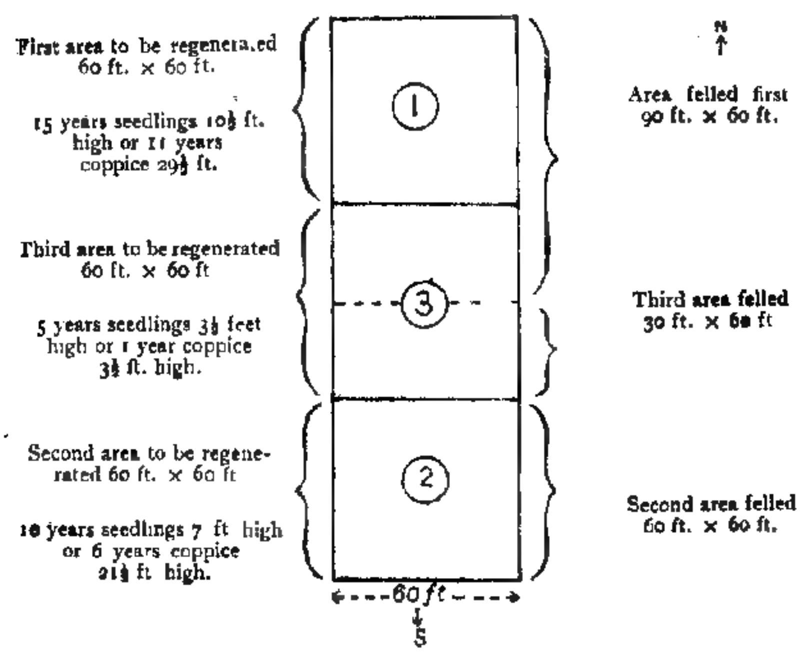
(d) The regeneration period to be 15 years divided into three sub-periods of five years each.

(e) Each strip of the regeneration area to be divided into segments, the length of each segment to be three times the width of the strip, *i.e.*, in this case 180 ft, and each segment to contain 3 unit areas, each 60 ft. by 60 ft. The first unit will be dealt with in the first sub-period of five years, the second in the second

sub-period and the third in the third and last sub-period. An interval of four years to elapse between the felling of any two units in the same segment. In this way the rapid clearing of large areas and the establishment of a strong growth of weeds will be prevented.

(*f*) In the area to be regenerated during each sub-period of five years, those units which are already stocked with young growth and which merely require cutting back should be felled in the last 1—2 years of the sub period. This will tend to make the young crop uniform and will also prevent excessive shade on the south of unit ② from high coppice growth in unit ① to the south of it.

(*g*) The area to be felled and regenerated, respectively, in a sample segment is indicated below, together with the age and approximate height of the young growth at the end of 15 years in a segment which has been successfully regenerated.



It will be noticed that south of unit (1) an area 60 ft. × 30 ft. is felled in addition to the unit area itself, in order to diminish the shade on the south.

(*h*) During the first rotation, owing to the large quantity of advance growth of varying ages in the forest, most of which, if cut back, will produce vigorous shoots suitable for retention in the new crop, there must be considerable irregularity in the new crop, the coppice growth being naturally far more vigorous, at all events at first, than the young seedling growth. In the second rotation there will probably be much less old advance growth and the young crop will be more uniform.

(*i*) The regeneration period should be considered to commence from the time of the first sowing.

(*k*) In the areas to be regenerated felling should be done as early as possible in the cold season, so that the soil may be well moistened by dew and light showers. All dead leaves and débris to be burnt and the soil hoed in April-May following.

(*l*) As a rule a large quantity of natural seed will reach the regeneration areas but this cannot be depended on and seed must be sown broadcast at the rate of 6 seeds per square foot of area, in order to secure a fairly full stock of seedlings even in unfavourable seasons.

In dry forests where the seedlings suffer chiefly from drought it is possible, as has been pointed out above, that an east-west direction for the strips may be advisable and in such cases the felling of an additional area 60 ft. × 30 ft. in addition to unit area (1) would be unnecessary. In order to give the maximum shade from the hot afternoon sun, also, in such cases the unit areas should probably be arranged (1), (2) and (3) consecutively from east to west, instead of (1), (3) and (2) from north to south as has been proposed above for moist forests.

In the system which has been sketched above it will be noticed that the fellings are scattered through the forest which is obviously

ess convenient than if they were concentrated in one part of the forest. At the same time they are situated on definite strips and are more concentrated than in the selection, compartment or group systems. On the other hand, the small scattered felling areas are advantageous in hindering the establishment of a strong growth on weeds and probably also in decreasing damage by insects. In the future, it may be found possible to further improve upon the system which is now suggested, *e.g.*, by attacking a wood on one side and then letting the strip fellings proceed progressively through the wood by gradually enlarging the original strip. The experiments which have been carried out indicate that, in moist forest, when side shade is received from one direction only, side shade from the west is the best. Thus, it may eventually prove possible to regenerate these forests by progressive strip fellings passing from the east through the forests towards the west. Similarly, in the case of dry forests, it may eventually prove possible to regenerate them by progressive strip fellings passing from the north or north-east towards the south or south-west respectively. Whether such modifications are possible, however, without causing excessive weed growth or subsequent damage to the young growth by frost or drought cannot be decided until a good deal of further experimental work has been carried out. Meanwhile it is maintained that a determined effort ought now to be made to apply in one or two selected forests the system which has been sketched above, which has been shown to be safe and practicable by the experimental evidence which is now available and which offers a good prospect of reducing the regeneration period by no less than 35 years. By putting this system into operation, also, in selected areas, a standard will be made available by means of which it will be easy to determine the comparative value of improvements and modifications which may be subsequently suggested. Finally, it should be noted that the suggested system is eminently suited for those forests which are composed chiefly of miscellaneous species and in which it is desirable to increase the proportion of sal.

R. S. HOLE.

CAUSE OF THE SPIKE DISEASE OF SANDAL.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

Mr. Fischer, in his article on this subject published in the *Indian Forester* for December 1918, first considers it unfortunate that my comment on Mr. Venkataramana Ayyar's article was published together with the article in the same issue of the *Forester*, since "this has probably weakened the force of an admirable exposition of the state of affairs in the Javadis." Seeing that my comment referred to no statement of fact but merely to the opinions expressed regarding the bearing of certain facts on the theory of sap circulation, it is not easy to see how such comment can in any way have weakened the exposition of actual facts.

Incidentally it may be pointed out that the publication of comments on papers published in the same number of the *Indian Forester* is no new procedure. In the May number of the *Indian Forester* for 1901, Vol. XXVII, p. 240, a comment by "F. G." was published on a note of mine which appeared in the same number.

Mr. Fischer then complains that I have not defined what I mean by *prolonged*. Seeing that the precise effect of prolonged abnormal accumulation of carbohydrates in the leaves on the physiological processes of the Sandal tree has never yet been experimentally determined it is obviously impossible to define precisely the period necessary to decide whether or not this condition is likely to cause spike. At the same time I have already stated that, if the experiments are carefully conducted, proof should be available "probably in one or two years" (*Indian Forester*, October 1917, p. 439).

Mr. Fischer's remarks regarding the complete scorching of three individual trees by fire appear to call for no further comment than that already made with reference to similar cases reported by Mr. Ayyar (*Indian Forester*, July 1918, p. 327). On the other hand, Mr. Tireman has just reported that burning one of the experimental areas in Coorg has been followed by the appearance of a case of typical spike situated about three-fourths of a mile from the nearest previous case of spike. At the same time, although

interesting, a single case like this cannot of course be regarded as conclusive.

Mr. Fischer "cannot conceive, were Mr. Hole's unbalanced sap theory correct, why spike should spread from a centre.' He does not appear to have read my remarks on this point (*Indian Forester*, October 1917, p. 437).

Mr. Fischer then records his opinion that the theory of an unbalanced circulation of sap "is not very convincing to those who have had much practical experience of spike in Sandal." If this is so, presumably there are more weighty arguments against the theory than those which have been adduced by Mr. Fischer.

Mr. Fischer considers that spike is caused by *ultra-microscopic organisms* and states that this cause has been advanced as an explanation of the mosaic leaf-disease of tobacco. In a recent paper, Freiberg maintains that mosaic diseases are due to an enzyme and not to an organism (*Ann. Miss. Bot. Gar.*, IV, pp. 175—232, April 1917). The fact that no organisms can be seen with the microscope, moreover, is not the only reason for the belief that organisms are not responsible. The infective principle in the case of mosaic disease, for instance, is not destroyed by prolonged treatment with concentrated solutions of antiseptics such as chloroform, ether and others which would certainly be expected to destroy a living organism.

Mr. Fischer considers that Dr Coleman's experiments showing that spike can be communicated by grafting "indicate in no unhesitating manner the line of further action and one likely to lead to a more fruitful harvest." Dr Coleman has a rich field for his activities in the very valuable Sandal forests of Mysore in which spike is said to cause an annual loss of more than four lacs of rupees and he has received the promise of financial support for his work on this disease from the Government of India. There is no reason to fear that Dr. Coleman will fail to make the most of his opportunities or to follow up the line of action indicated by his experiments.

In this connection it is interesting to note that Dr. Erwin F. Smith had proved so long ago as 1891 that the disease known as

peach yellows (which in many respects is very similar to the Sandal spike disease) could be communicated by budding. Dr. Smith is now Pathologist in charge of the Laboratory of Plant Pathology in the United States Department of Agriculture and in a recent letter to me, dated 26th January 1918, Dr. Smith says. —

"I abandoned work on peach yellows and peach rosette a long time ago, in order to save my reputation, so to speak, not having been able to find the cause of either disease. * * * There has been very little published in this country in recent years on this disease and our knowledge of it has been for a long time at a standstill. It still does a great deal of damage in places."

Mr. Fischer does not make it clear why he considers a fruitful harvest is likely to be realized from Dr. Coleman's grafting results when such a harvest still remains a desideratum in the case of *peach yellows, in spite of the results obtained in* Erwin Smith's budding experiments twenty-eight years ago.

Mr. Fischer's theory that spike may be communicated by insects which harbour ultra-microscopic organisms is, it is understood, now being tested by experiments in Madras. It is certainly desirable that these experiments should be completed and the theory, if possible, either proved or disproved. Even if the possibility of the transmission of infection by insects, however, is *established, this would not necessarily also prove that the infective* principle was an organism. It might possibly be an injurious enzyme. The possibility of a connection between insects and spike disease has never been denied by me (see *Indian Forester*, October 1917, p. 436), and I have consistently advocated the importance of having this connection thoroughly investigated by local officers working in co-operation with the expert staff of the zoological branch of the Dehra Dun Research Institute. In view of the great increase of staff now proposed in this branch at Dehra Dun, there is every reason to hope that this will be done.

There are, therefore, no grounds for Mr. Fischer's fears that work *undertaken in accordance with my suggestions will in any* way interfere with the other lines of work which have been initiated and which are now being carried on.

Assuming then that my suggestions are not likely to be actually inimical to progress in the way which has been suggested by Mr. Fischer, it remains to be considered whether in other respects they are likely to be of any value.

In the past there has been a tendency to argue as follows :—"Since spike is known where a particular factor (*e.g.*, lantana) does not exist, therefore this factor can have nothing to do with the disease."* Reasoning of this kind has, I think, been, in great measure, responsible for the lack of progress made in the control of this disease up to date. There is no doubt that it has tended to obscure the importance of, and to prevent the extension of work of the kind done by Mr. Tireman in Coorg, in carefully observing in the forest the connection between the incidence of the disease and various factors (such as the existence of lantana, occurrence of fires, etc.) and in then experimentally testing the effect of such factors individually on the incidence of the disease with the object of ultimately securing some degree of control over the disease through these factors. In a preliminary note sent in March 1917 to various officers interested in the disease, I strongly emphasized this point, stated that "we have as yet no conclusive evidence regarding any single factor which will enable us definitely to state that this factor cannot, under some conditions, either produce or at all events favour the spread of spike," and urged the importance of extending work of the kind done by Mr. Tireman. Subsequently I pointed out that a number of different factors, by interfering with normal sap-circulation, were probably able to cause an abnormal accumulation of carbohydrates in the leaves and suggested that if this abnormal condition is prolonged it may produce the diseased condition known as spike, probably as a result of abnormal enzymatic activity. Experiments were also suggested to test the effect of four factors which in Coorg appeared to be connected with an increased virulence of the disease (*Indian*

* A similar argument which has been used and which, it is believed, has also been misleading is "because a particular factor (*e.g.*, a fungus) is found on trees which appear to be healthy, therefore this factor cannot be the cause of the disease," see *Indian Forester*, July 1918, p. 333

Forester, 43, October 1917, pp. 429–442, and *Journ. As. Soc. Beng.* XIV, p. 164, August 1918). Whether these experiments will prove that these factors can produce the disease by setting up abnormal metabolism and enzymatic action, or otherwise, remains to be seen. Whether this is proved or not, however, there is little doubt that work on these lines will indicate the so-called predisposing causes which assist the disease and it is interesting to note that Dr. E. J. Butler, Imperial Mycologist to the Government of India, in a recent letter recommending that the experiments suggested by me should be carried out, states that "the defining of such predisposing causes is often not less important in devising methods of control than the discovery of the first cause."

It is maintained, therefore, that this line of action which has been recommended is sound and is likely to help us to quickly attain our primary object, *viz.*, a practical means of preventing, or decreasing, the incidence of spike. It is a line of action also in which, as Mr. Fischer remarks, all local Forest Officers can take part and materially assist.

A second line of action which seems to promise good results is indicated below :—

Based on the work of E. F. Smith on Crowngall, W. B. Brierley has recently reported a case (*Kew Bulletin*, 1917, p. 326), in which the saprophyte or weak parasite *Botrytis cinerea* caused the tissues of a plant to develop abnormally at some distance away from the actual hyphæ, the tissues apparently having been stimulated by a highly diluted enzyme excreted by the fungus. The frequent connection between spike and the widespread death of twigs, apparently caused by weak parasitic fungi, has already been emphasized (*Indian Forester*, July 1918, pp. 330—334). The effect of this damage and these fungi on the nutritional processes of the plant as a whole and especially on the sap-circulation and movements of carbohydrates is a matter that certainly requires investigation and, in addition to this, there is the possibility that the abnormal growth known as spike may be caused by a very dilute solution of an enzyme excreted by these twig-killing fungi and which may only be able to enter the main ascending water current

of the plant when the damage to the twigs is unusually severe or prolonged, when the plant itself has been weakened by other factors, or under other conditions favourable to the penetration of the fungus. It is remarkable that such a hypothesis which involves no extravagant stretch of imagination would harmonize with practically all the theories which have as yet been advanced regarding the cause of this disease. Among such theories may be noted :—

(1 C. D. McCarthy's opinion that "something of the nature of a ferment is communicated to the sap" (1899).

(2) Dr. E J. Butler's opinion that the disease "may be due to the circulation of a poison in the sap" (1903).

(3) Dr. L. C. Coleman's opinion that the disease "is in all probability produced by a virus" (1917).

(4) H. A. Latham's opinion that spike is due to fungi (1916—1918).

(5) R. S. Hole's opinion that the disease is a result of the prolonged action of various injurious factors, such as fire, damage to hosts, suppression and damage by twig killing fungi (1917-18).

It is thus by no means improbable that the complete solution of this perplexing disease will eventually be attained not by a single expert working at one aspect of the problem but by a combined advance along different lines of attack and that this solution will show that there is much truth in, and justification for, the various theories that have been advanced from time to time.

Good work is at present being done at Dehra Dun on the connection between fungi and spike by the Assistant Forest Botanist, Mr. Abdul Hafiz Khan. I have also, in April last, submitted proposals for the expansion of the staff of the botanical and chemical branches of the Dehra Dun Research Institute and, if these proposals are sanctioned, there will shortly be available, in addition to Mr. Hafiz Khan, European experts in Œcology Mycology, Bacteriology and Biological Chemistry for the study of this disease in its various aspects, in co-operation with the local Forest Officers in the Sandal tracts.

From what has been said above, therefore, it will, I think, be clear that I have endeavoured to secure :—

(1) The co-operation of local Forest Officers in Sandal areas in studying the effects of various œcological factors which are themselves possibly the cause of spike and which, in any case, are likely to help us materially in the near future in controlling the disease and reducing its virulence.

(2) The full and satisfactory solution of the problem through the co-operation of various experts fully qualified to deal with its different aspects.

In conclusion, the following extract referring to *Zizyphus Œnoplia* is of interest : "Some of the branches very often produce a mass of crowded slender branchlets covered closely with very small nearly glabrous, membranous, pale green leaves very different from the normal ones, and with straight, slender, spinous stipules ; such branches are flowerless. I have seen a similar dimorphic state from Khasia." (Trimen's *Flora of Ceylon*, I, p. 281, 1893.) This appears to indicate that spike in *Zizyphus* was widely distributed as early as 1893 and that it is probably, therefore, of considerable antiquity.

THE FOOD PLANTS OF INDIAN FOREST INSECTS.

BY C. F. C. BEESON, M.A., I.F.S., FOREST ZOOLOGIST.

PART II.

[*Continued from Indian Forester, pp.* 49—56.]

BUPRESTIDÆ.

Acmæodera kerremansi, Stebbing.

Sapwood borer.—*Dalbergia Sissoo.*

Distribution.—Lahore, Punjab.

Acmæodera stictipennis, Cast. et Gory.

Sapwood borer.—*Bauhinia Vahlii, Shorea robusta.*

Distribution.—[Central Provinces; Bengal; Madras; Bombay Philippines]; Siwaliks; Gonda, United Provinces.

Agrilus birmanicus, Kerr.

Sapwood borer.—*Dalbergia Sissoo.*

Distribution.—[Burma]; Lahore, Punjab.

Agrilus salweenensis, Stebbing.

Sapwood borer.—*Xylia dolabriformis.*

Distribution.—Tharrawaddy, Burma.

Ancylocheira geometrica, Cast. et Gory.

Sapwood borer.—*Pinus longifolia.*

Distribution.—[Bengal]; Rawalpindi, Simla, Punjab; Chamba State; Almora, Naini Tal, Chakrata, U. P.

Ancylocheira kashmirensis, Fairmaire.[10]

Sapwood borer.—*Cedrus Deodara.*

Distribution.—Chamba State; Chakrata, U. P.

Anthaxia marshalli, Stebbing.

Sapwood borer.—*Dalbergia Sissoo.*

Distribution.—Lahore, Punjab.

Anthaxia notaticollis, Chevrol.

Sapwood borer.—*Pinus longifolia.*

Distribution.—Naini Tal, Mussoorie, U. P.

Anthaxia osmastoni, Stebbing.

Sapwood borer.—*Pinus longifolia.*

Distribution.—Naini Tal, U. P.

Belinota prasina, Thunb.

Sapwood borer.—*Mangifera indica, Buchanania latifolia, Psidium guava,*[11] *Sapium sebiferum, Terminalia belerica, Terminalia paniculata.*

Distribution.—[India; Ceylon; Malaya; Madagascar; Seychelles.]

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[10] Stebbing, 1914, p. 212 gives? *Quercus incana* as the tree attacked by this species on the evidence of a beetle found by him on the bark

[11] Fletcher, 1917, B., p. 231.

Capnodis indica, Thoms.

Wood borer.—*Eugenia jambolana, Pinus longifolia.*

Distribution.—Rawalpindi, Simla, Punjab; Chakrata, Almora, U. P.; Tehri Garhwal.

Capnodis miliaris, Klug.

Wood borer.—*Pinus gerardiana, Platanus orientalis, Populus euphratica.*

Distribution.—[Turkey; Caucasus; Armenia; Syria; Persia; Mesopotamia; Baluchistan; Kashmir.]

Capnodis vermiculata, Fairmaire.

Wood borer.—*Pinus longifolia.*

Distribution.—[Kashmir]; Rawalpindi, Punjab; Naini Tal, Almora, U. P.

Chrysochroa [Megaloxantha] Bicolor, Fabr.

Wood borer.—*Theobroma cacao,*[12] *Xylia dolabriformis.*

Distribution.—[Assam; Sikkim; Indo-China; Malaya]; Darjeeling, Kurseong, Buxa, Bengal; Rangoon, Burma.

Chrysochroa [Catoxantha] opulenta, Gory.

Wood borer.—*Chikrassia tabularis, Lagerstrœmia Flos-Reginæ.*

Distribution.—[Sikkim; Assam; Indo China; Malaya.]

Chrysochroa vittata, Fabr.

Wood borer.—*Chikrassia tabularis, Lagerstrœmia Flos-Reginæ.*

Distribution.—[India; Siam; China.]

Chrysobothris indica, Cast. et Gory.

Sapwood borer.—*Shorea robusta, Terminalia tomentosa.*

Distribution.—[Andamans; Java]; Siwaliks, Lansdowne, Ramnagar, U. P.; Tenasserim, Burma.

Chrysobothris quadraticollis, Kerr.

Sapwood borer.—*Terminalia tomentosa.*

Distribution.—[Bengal], Tenasserim, Burma.

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[12] Zehnter, 1901, p. 8.

Chrysobothris sexnotata, Gory.

Sapwood borer.—*Shorea robusta.*

Distribution.—[Java ; China] ; Siwaliks, U. P. ; Bengal ; Andamans.

Psiloptera [Lampetis] fastuosa, Fabr.

Wood borer.—*Acacia arabica, Swietenia macrophylla, Tectona grandis.*

Distribution.—[India.]

Psiloptera [Lampetis] viridans,—Kerr.

Sapwood borer.—*Shorea robusta, Terminalia tomentosa.*

Distribution.—[Sylhet] ; Mandla, C. P., Kanara, Bombay ; Ceylon.

Sphenoptera aterrima, Kerr.[18]

Sapwood borer.—*Cedrus Deodara.*

Distribution.—Simla, Bashahr, Punjab ; Chakrata, Mussoorie, U. P.

Sphenoptera lafertii, Thoms.

Sapwood borer.—*Cedrus Deodara.*

Distribution.—[Moradabad] ; Chamba State.

Sphenoptera cupriventris, Kerr.

Sapwood borer.—*Anogeissus latifolia*

Distribution.—[Bengal] ; Kanara, Belgaum, Bombay.

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[18] Stebbing in Indian Forest Insects, 1914, omits all references to previous literature on this species ; the correct synonomy is as follows :—

Buprestid borer, Stebbing, 1902 Departmental Notes on Insects that affect Forestry No. 1, pp. 49—51.

Chrysobothris sp. Stebbing, 1908 Forest Pamphlet, No. 2 "The Bark Boring Beetle Attack in the Coniferous Forests of the Simla Catchment Area," pp. 19—22, plate V, figs. 1—6.

Chrysobothris sp. Stebbing, 1911, Indian Forest Memoirs, II, i "On some important Insect Pests of the Coniferæ of the Himalaya, pp. 24—28, plate IV, figs. 1a-b, V VI.

Buprestid beetle, Hole, 1912, Forest Bulletin, No. 10, "Bark Boring Beetle Attack in the Coniferous Forests of the Simla Catchment Area, 1907—1911."

C. F. C. B.

CERAMBYCIDÆ.

Acanthophorus serraticornis, Oliv.

Heartwood borer. –*Mangifera indica, Shorea robusta.*

Distribution. –[Madras ; Mysore] ; Sikkim, Singbhoom, C. P. ; Cochin.

Aegosoma costipenne, White.

Heartwood borer.—*Tectona grandis.*

Distribution.—[Assam ; Manipur ; Sikkim.]

Aeolesthes holosericea, Fabr.

Heartwood borer.—*Acacia arabica, Butea frondosa, Cedrela Toona, Chloroxylon Swietenia, Cynometra ramiflora, Hardwickia binata, Pinus longifolia, Sapium sebiferum, Shorea robusta, Tamarix articulata, Terminalia belerica, Terminalia tomentosa.*

Distribution. –[North-west India ; Bombay ; Nilgiris ; Ceylon ; Assam ; Tenasserim ; Andamans and Nicobars ; Siam ; Malay Peninsula] ; Chakrata, Siwaliks, Haldwani, Naini Tal, Western Almora, Ramnagar, Kheri, Bahraich, Gonda, Gorakhpur, U. P. ; Buxa, Jalpaiguri, Tista, Darjeeling, Sunderbans, Bengal ; Darrang, Goalpara, Assam ; Mandla, C. P. ; Hyderabad, Ganjam, Madras ; Dehra Ismail Khan. [Probably India, Indo-China and Malaya.]

Aeolesthes induta, Newm

Heartwood borer.—*Chloroxylon Swietenia.*

Distribution.—[Ceylon ; Upper Burma ; Siam ; Java ; Philippines.]

Aeolesthes sarte, Solsky.

Heartwood borer.—*Platanus orientalis, Populus alba, Populus euphratica, Salix alba, Salix babylonica.*

Distribution.—[Baluchistan ; Afghanistan ; Turkistan ; West Thibet.]

Aphrodisium cantori, Hope.

Heartwood borer.—*Mallotus philippinensis.*

Distribution.—[Assam]; Siwaliks, Gorakhpur, U. P.

Ceresium nilgiriense, Gahan.

Sapwood borer.—*Shorea robusta.*

Distribution.—[Southern India; Ceylon]; Gorakhpur, U. P.

Ceresium simplex, Gyll.

Sapwood borer.—*Casuarina equisetifolia.*

Distribution.—[N. India Burma, Tenasserim Ceylon, Malaya]; N. Arcot, Madras

Ceresium zeylanicum, White.

Sapwood borer.—*Heritiera Fomes, Shorea robusta.*

Distribution.—[Ceylon; Assam; Tenasserim; Borneo]; Sunderbans, Bengal; Goalpara, Assam.

Chlorophorus annularis, Fab.

Wood borer.—*Dendrocalamus strictus, Shorea robusta.*

Distribution.—[N.-W. India to Assam; Burma; Siam; Malaya.]

Criocephalus tibetanus, Sharp[14].

Sapwood borer.—*Cedrus Deodara, Pinus Gerardiana.*

Distribution.—[Thibet]; Baluchistan; Chakrata, U. P.

Derolus discicollis, Gahan.

Sapwood borer.—*Acacia modesta, Heritiera Fomes.*

Distribution.—[Karachi], Rawalpindi, Punjab; Sunderbans, Bengal.

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[14] The figure given by Stebbing, 1914, Indian Forest Insects p. 287, (fig 197), is obviously not of *Criocephalus tibetanus*, Sharp, but in all probability of *Plocaederus obesus*, Gahan.—C. F. C. B.

Derolus volvulus, Fabr.

Wood borer.—*Bombax malabaricum, Shorea robusta, Xylia dolabriformis*

Distribution.—[India ; Philippines ; China.]

Dialeges pauper, Fabr

Heartwood borer.—*Milletia auriculata, Shorea robusta.*

Distribution.—[Darjeeling ; Assam ; Malay Peninsula ; Borneo] ; Siwaliks, N. Kheri, Gonda, Gorakhpur, U. P. ; Buxa, Jalpaiguri, Tista, Bengal ; Goalpara, Assam.

Diorthus cinereus, White.

Heartwood borer.—*Bauhinia Vahlii, Heritiera Fomes, Shorea robusta*

Distribution.—[Baluchistan ; Bengal ; Madras ; Ceylon ; North Burma ; Siam ; Java] ; Siwaliks, Lansdowne, Gonda, Gorakhpur, U P. ; Sunderbans, Bengal.

Euryphagus lundi, Fab.

Heartwood borer.—*Shorea robusta.*

Distribution.—[Assam ; Burma ; Malaya] ; Buxa, Tista, Bengal ; Sikkim.

Gelonætha hirta, Fairm.

Sapwood borer.—*Heritiera Fomes, Tectona grandis.*

Distribution.—[Calcutta ; Coromandal Coast ; Nilgiris ; Siam ; Philippines], Sunderbans, Bengal ; Taungyi, Katha, N. Shan States, Burma.

Hoplocerambyx spinicornis, Newm.

Heartwood borer.—*Duabanga sonneratioides, Pentacme suavis, Shorea obtusa, Shorea robusta.*

Distribution.—[Nepal ; Assam ; Tenasserim ; Burma ; South Afghanistan ; Malaya] ; Siwaliks, Lansdowne, Ramnagar, Kheri, U. P. ; Buxa, Jalpaiguri, Tista, Bengal ; Goalpara, Assam ; Mandla, Singhbhoom, C. P.

Hypœschrus indicus, Gahan.

Sapwood borer.—*Shorea robusta.*

Distribution.—[Karachi ; Calcutta, Belgaum] ; U. P.

Lophosternus hugelii, Redtenb [15].

Heartwood borer.—*Pyrus Malus*[16], *Quercus ilex*, *Quercus incana.*

Distribution.—[Kashmir ; N.-W. Frontier ; Punjab ; Assam] ; Bashahr State ; Mussoorie, W. Almora, Naini Tal, Siwaliks, U. P.

Leptura rubriola, Bates.

Sapwood borer.—*Cedrus Deodara, Picea Morinda.*

Distribution.—[Kashmir ; Murree] ; Chamba State ; Naini Tal, West Almora, U. P.

Macrotoma crenata, Fab.

Heartwood borer.—*Quercus dilatata, Bombax malabaricum.*

Distribution.—[Kashmir to South Bombay, and Nepal to Calcutta, Ceylon ; Burma] ; Chakrata, U. P.

Macrotoma plagiata, Waterh.

Heartwood borer.—*Heritiera Fomes.*

Distribution.—[North India] ; Sunderbans, Bengal.

Macrotoma spinosa, Fab.

Heartwood borer.—*Casuarina equisetifolia.*

Distribution.—[Arabia ; Bengal ; Nilgiris ; Bangalore] ; Salem, Madras.

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[15] On pages 275-276 of Indian Forest Insects, Stebbing refers to specimens of *Paraphrus granulosus*, Thoms. as taken by Mr. A. J. Gibson in July 1909 in *Quercus ilex*, in Bashahr State. This material is represented by one specimen in the Institute collection bearing the following data, "Specimen No. 50 of 23rd July 1909, from A. J. Gibson, Bashahr State, 23rd July 1909, *Quercus ilex*, No, *nil*, dated 18th Jul 1909, *Paraphrus granulosus* or n. sp.," all in Stebbing's handwriting.

I have determined the specimen to be *Lophosternus hugelii*, Redtenb., and Gahan has confirmed the identification Stebbing's record for the former species should be deleted.—C. F. C. B.

[16] Fetcher, 1917, B, p 240

Massicus unicolor, Gahan.

Heartwood borer.—*Quercus Griffithii.*

Distribution.—[Assam; Patkai Mts]; Taungyi, S. Shan States, Burma.

Nothorhina muricata, Dal.

Sapwood borer.—*Pinus longifolia.*

Distribution.—[Europe]; Chamba State; Rawalpindi, Punjab, Tehri Garhwal State; Naini Tal, West Almora, S. Garhwal, Chakrata, U. P.

Nyphasia apicalis, Gahan.

Sapwood borer.—*Shorea robusta.*

Distribution.—[Kanara, Bombay], Siwaliks, U. P.

Perissus mutabilis, Gahan.

Sapwood borer.—*Shorea robusta.*

Distribution.—[Sikkim; Burma; Tenasserim; Siam]; Siwaliks, U. P.

Plocæderus obesus, Gahan.

Heartwood borer.—*Bombax malabaricum, Buchanania latifolia, Butea frondosa, Garuga pinnata, Gmelina arbirea, Mangoiera indica, Odina Wodier, Shorea robusta.*

Distribution.—[N. India; Sikkim; Calcutta; Assam; Burma; Siam; Andamans]; Siwaliks, Kheri, Gonda, Gorakhpur, U. P.; Tista, Bengal; Ganjam, Madras.

Purpuriscenus haussknechti, White.

Heartwood borer.—*Populus ciliata.*

Distribution.—[Kashmir; Punjab; Turkestan]; Baluchistan.

Purpuriscenus montanus, White.

Sapwood borer.—*Pinus excelsa.*

Distribution.—[W. Kashmir; Cambellpore; Thibet]; Tehri Garhwal State; Naini Tal, Chakrata, U. P.

Remphan hopei, Waterh.

Heartwood borer.—*Dipterocarpus turbinatus.*

Distribution.—[Andamans; Pegu, Mergui; Siam; Penang, Borneo]; N. Toungoo, Burma.

Rhytidodera robusta, Gahan.

Heartwood borer.—*Shorea robusta.*

Distribution.—[Bombay; Bangalore]; Siwaliks, U. P.

Stromatium barbatum, Fabr[17].

Drywood borer.—*Abies Webbiana, Acacia arabica* (sapwood), *Acacia catechu* (sapwood), *Acacia dealbata, Acacia eburnea, Acacia Farnesiana, Acacia Intsia, Acacia Jacquemonti*

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[17] The list of Trees, Shrubs and Climbers from which *Stromatium barbatum* has been bred out is based mainly on the wood specimens in the museum of the Forest Economist at the Research Institute, Dehra Dun. The record shows that the borer ordinarily attacks dry timber ranging in hardness from soft to hard (Gamble's classification), and avoids equally very soft woods and very hard woods, although the sapwood of the latter may be attacked. For example, in the case of the species of the genus *Acacia* the distribution of attack is roughly as follows:—[1] Sapwood and Heartwood attacked.—*Dealbata* (M. H.), *Eburnea* (H.), *Farnesiana* (H.), *Intsia* (S.), *Pennata* (M. H.), *Senegal* (H.); [2] Sapwood only attacked.—*Arabica* (H.), *Catechu* (V. H.), *Jacquemonti* (H.); *Latronum* (V. H.), *Leucophlœa* (H.); [3] Not attacked.—*Ferruginea* (V.H.), *Melanoxylon* (M. H.), *Modesta* (E. H.), *Suma* (V. H.), *Sundra* (V. H.), In the case of the genus *Dalbergia* specimens show the following relative attack:—[1] Sapwood and Heartwood attacked.—*Hircina* (M. H.), *Kurzii*, (H.), *Lanceolaria* (M. H.), *Ovata* (M. H.), *Paniculata* (S.), *Rimosa* (S.), *Stipulacea* (M. H.), *Volubilis* (H.); [2] Sapwood only attacked.—*Latifolia* (E. H.); [3] Not attacked.—*Cultrata* (V. H.), *Oliveri* (H.), *Sissoo* (V. H.).

There is no discrimination on the part of the borer, between shrubs and timber trees, provided the required woody growth is present, a condition which apparently does not obtain in palms and trees with loose fibrous tissue.

No positive conclusions can be drawn as to the nature of the specific conditions most acceptable to the borer. Some of the wood specimens have been exposed in the museum for twenty years without being attacked. Other specimens of the same tree species have been bored in the first year of exposure in the museum, and within two or three years after the felling of the tree from which the blocks were prepared; other specimens have remained immune for over ten years before receiving attention from the borer.

Stebbing (1914, p. 293), and Khare (1916, p. 611), consider that this species is a borer of green trees (*i.e.*, *Tectona grandis* and *Citrus aurantium*) but neither produces conclusive evidence for this assumption.—C. F. C. B.

S = soft, H. = hard, M = moderately, V = very, E = extremely.

(sapwood), *Acacia Latronum* (sapwood), *Acacia leucophlæa* (sapwood), *Acacia pennata*, *Acacia Senegal*, *Acer caudatum*, *Acer cultratum*, *Acer villosum*, *Aegle Marmelos*, *Aesculus indica*, *Albizzia lebbekoides*, *Albizzia lophantha*, *Albizzia stipulata*, *Anogeissus sericea*, *Anona squamosa*, *Anthocephalus Cadamba*, *Ardisia humilis*, *Averrhoa Carambola*, *Bauhinia purpurea*, *Bauhinia racemosa*, *Beaumontia grandiflora*, *Betula acuminata*, *Betula utilis*, *Bischofia javanica*, *Boswellia serrata*, *Bridelia tomentosa*, *Butea frondosa*, *Carallia integerrima*, *Carapa moluccensis*, *Carpinus viminea*, *Cassia auriculata*, *Cassia nodosa*, *Cassia siamea*, *Casuarina equisetifolia*, *Cedrus Deodara*, *Celtis australis*, *Chloroxylon Swietenia*, *Cinnamomum glanduliferum*, *Cinnamomum Tamala*, *Citrus aurantium*, *Citrus decumana*, *Citrus medica*, *Clausena Wampi*, *Clerodendron Colebrookeanum*, *Coffea arabica*, *Cordia Myxa*, *Cornus macrophylla*, *Corylus Colurna*, *Corylus ferox*, *Cotoneaster bacillaris*, *Cotoneaster microphylla*, *Cratægus crenulata*, *Cratægus oxyacantha*, *Cudrania javanensis*, *Dalbergia hircina*, *Dalbergia Kurzii*, *Dalbergia latifolia* (sapwood only), *Dalbergia lanceolaria*, *Dalbergia ovata*, *Dalbergia paniculata*, *Dalbergia rimosa*, *Dalbergia stipulata*, *Dalbergia volubilis*, *Debregeasia hypoleuca*, *Dendrocalamus strictus*, *Desmodium tiliæfolium*, *Deutzia corymbosa*, *Deutzia staminea*, *Diospyros Chloroxylon*, *Diospyros Embryopteris*, *Diospyros humilis*, *Diospyros Kaki*, *Diospyros Melanoxylon* (sapwood only), *Diospyros microphylla*, *Diospyros montana*, *Diospyros tomentosa*, *Docynia indica*, *Eleagnus latifolia*, *Eleaocarpus lanceæfolius*, *Eriobotrya dubia*, *Eriobotrya japonica*, *Eriobotrya petiolata*, *Erythrina suberosa*, *Eucalyptus calophylla*, *Eucalyptus globulus*, *Eucalyptus tereticornis*, *Eugenia bracteata*, *Euonymus frigidus*, *Euonymus hamiltonianus*, *Euonymus lacerus*, *Feronia elephantum*, *Ficus glaberrima*, *Ficus hispida*, *Ficus nemoralis*, *Ficus retusa*, *Ficus scandens*, *Fraxinus floribunda*, *Gamblea ciliata*, *Garcinia Wightii*, *Gardenia obtusifolia* *Gardenia turgida*, *Glochidion lanceolarium*, *Gouania leptostachya*, *Grevillea robusta*, *Grewia asiatica*, *Grewia lævigata*, *Grewia oppositifolia*, *Gynocardia*

odorata, *Hedera Helix*, *Helicia robusta*, *Helicteres Isora*, *Heteropanax fragrans*, *Hiptage Madablota*, *Holigarna longifolia*, *Holmskioldia sanguinea*, *Hypericum mysorense*, *Ilex dipyrena*, *Ilex sikkimensis*, *Ilex Wightiana*, *Indigofera heterantha*, *Indigofera pulchella*, *Kydia calycina*, *Lagerstræmia villosa*, *Larix Griffithii*, *Lasiosiphon eriocephalus*, *Leucomeris spectabilis*, *Litsæa Wightiana*, *Machilus Duthiei*, *Machilus odoratissima*, *Magnolia Campbellii*, *Mallotus nepalensis*, *Mallotus philippinensis*, *Mappia fœtida*, *Mangifera indica*, *Meliosma dilleniæfolia*, *Meliosma pungens*, *Meliosma Thomsoni*, *Michelia nilagirica*, *Milletia Brandisiana*, *Milletia pulchra*, *Milletia racemosa*, *Morus alba*, *Myrica Nagi*, *Odina Wodier*, *Ougeinia dalbergioides*, *Oxyspora paniculata*, *Parkinsonia aculeata*, *Parrotia Jacquemontiana*, *Pentacme suavis*, *Philogacanthus thyrsiflorus*, *Photinia Notoniana*, *Piptadenia oudhensis*, *Piotanthus nepalensis*, *Pistacia integerrima*, *Pithecolobium bigeminum*, *Pittosporum eriocarpum*, *Pittosporum floribundum*, *Plecospermum spinosum*, *Poinciana elata*, *Poinciana regia*, *Polygala arillata*, *Pongamia glabra*, *Populus ciliata*, *Premna integrifolia*, *Prinsepia utilis*, *Prosopis spicigera*, *Prunus communis*, *Prunus eburnea*, *Prunus microcarpa*, *Prunus Padus*, *Prunus persica*, *Pyrus variolosa*, *Quercus dealbata*, *Quercus dilatata*, *Quercus ilex*, *Quercus incana*, *Quercus lanuginosa*, *Quercus semicarpifolia*, *Randia dumetorum*, *Randia uliginosa*, *Rhododendron argenteum*, *Rhododendron campanulatum*, *Rhododendron Falconeri*, *Rhus insignis*, *Rhus punjabensis*, *Ribes rubrum*, *Rosa macrophylla*, *Rosa moschata*, *Rosa sericea*, *Rubus lasiocarpus*, *Salix daphnoides*, *Salix elegans*, *Salvadora persica*, *Sapium sebiferum*, *Saurauja napaulensis*, *Sesbania ægyptiaca*, *Shorea obtusa*, *Shorea robusta*, *Shorea siamensis*, *Siphonodon celastrineus*, *Sonneratia apetala*, *Spiræa canescens*, *Spondias mangifera*, *Staphylea Emodi*, *Sterculia alata*, *Styrax serrulatum*, *Tectona grandis* (sapwood), *Terminalia belerica*, *Terminalia tomentosa*, *Toddalia aculeata*, *Torricellia tiliæfolia*, *Trewia nudiflora*, *Turpinia nepalensis*, *Ulmus Wallichiana*, *Viburnum coriaceum*, *Viburnum cotinifolium*, *Viburnum*

erubescens, Viburnum fœtens, Viburnum nervosum ; Woodfordia floribunda, Xylosma longifolium, Ziziphus nummularia, and the following exotic timbers : EUROPE:—*Acer pseudoplatanus, Aesculus hippocastaneum, Alnus glutinosa, Betula verrucosa, Carpinus betulus, Fagus sylvatica Populus tremula, Tilia parvifolia* :—NEW ZEALAND :—*Cordyline australis, Gaya lyallii. Myrsine urvillei, Olearia avicennifolia, Pittosporum eugenioides.*

Distribution.—[India ; Ceylon , Burma ; Anadamans ; etc.] ; Chamba ; Jaunsar , Kumaun.

Stromatium longicorne, Newm[18].

Sapling borer.—*Tectona grandis*

Distribution. [Assam ; Burma ; Siam ; Malaya.]

Teledapus dorcadoides, Pascoe.

Sapwood borer. *Cedrus Deodara, Picea Morinda.*

Distribution.—[Mussoorie ; Jaunsar] ; Chakrata, U. P.

Tetropium oreinum, Gahan[19].

Sapwood borer.—*Cedrus Deodara.*

Distribution.—[W. Kashmir] , Simla, Punjab ; Chakrata, U. P.

Xoanodera regularis, Gahan.

Wood borer.—*Ficus elastica.*

Distribution.—[N. India; Burma, Tenasserim] ; Darrang, Assam.

Xylotrechus buqueti, Lap et Gory.

Sapwood borer —*Shorea robusta.*

Distribution.—[Darjeeling ; Burma ; Andamans , Siam ; Java] ; Buxa, Jalpaiguri, Tista, Bengal.

Xylotrechus gahani, Steb. (nec. Duviv,[20].

Wood borer,—*Ficus elastica*

Distribution.—Darrang, Assam.

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18 There does not appear to be very strong evidence for supposing that this species bores into live teak saplings ; the original record (Ind Museum Notes, II, 1890, page 1) is of doubtful value. It is more probable that the species concerned is *Haplohammus cervinus*, Hopep., Lamiidæ, which causes cankers in teak saplings throughout India and Burma —C. F. C. B

19 This species has been confused in departmental literature with *Trinophylum cribratum*, Bates, see Beeson, 1915, pp 294, 295, for corrected synonomy —C F C. B.

20 *Xylotrechus gahani* —This name is already preoccupied by a species described from the Congo by Duvivier, 1891, Ann Soc Ent. Belge , XXXV C R., p. 379. I propose *renominatus* nom nov. for Stebbing's species —C. F. C. B

Xylotrechus smei, Lap. et. Gory[21].

Sapwood borer.—*Butea frondosa, Cassia fistula, Shorea robusta, Terminalia tomentosa.*

Distribution.—[Bhutan ; Calcutta ; Deccan] ; Siwaliks, Pilibhit, Lansdowne, Kheri, Gonda, Gorakhpur, U. P. ; Chota Nagpur, Buxa, Bengal ; Kurseong, Goalpara, Assam.

Xylotrechus quadripes, Chevr.

Wood borer —*Tectona grandis, Coffea robusta.*

Distribution —[Madras ; Coorg , Assam ; Sylhet , Burma ; Siam] ; N. Shan States

Xylotrechus stebbingi, Gahan[22].

Sapwood borer.—*Quercus dilatata.*

Distribution.—[Bashahr State ; Naini Tal, W. Almora.]

Xystrocera globosa, Oliv.

Wood borer.—*Albizzia lebbek, Albizzia procera, Bombax malabaricum, Xylia dolabriformis.*

Distribution.—[Mussoorie ; Darjeeling ; Assam ; Madras ; Mysore ; Bombay; Ceylon ; Burma ; Siam ; Malaya ; Egypt ; Hawaii] ; Siwaliks, U. P. ; Tenasserim.

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[21] Stebbing, 1909, Ind Forest Records, II, 1, pages 11—13, records *X smei,* Lap. et. Gory, from *Quercus dilatata* and figures the beetle on plate IV, fig. 5. This is, however, an error in determination for *X. stebbingi*, Gahan, *vide* foot-note 22 on that species —C. F. C B.

[22] Stebbing, 1915 Indian Forest Insects, p. 349, does not give the correct synonomy of this species ; it should be as follows :

Xylotrechus stebbingi, Gahan, 1906, Fauna of British India, Col., 1, Cerambycidæ, p. 244.

Xylotrechus vicinus, Stebbing, 1906 (nec. Lap et Gory, 1841, err. determ.) Dept Notes Ins. For. m. p. 24, plate IV, fig 2

Xylotrechus stebbingi, Stebbing, 1909, Ins. For. Rec., II, 1, pp. 9—11, plate IV, figs. 1—4.

Xylotrechus smei, Stebbing, 1909 (nec. Lap. et Gory, 1841, err. determ) *loc cit.,* pp 11—13, plate IV, fig. 5.

Xylotrechus stebbingi, Stebbing, 1915, Indian Forest Insects, pp. 349—351, fig. 237.– C. F. C. B.

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(To be continued.)

THE KALE VALLEY.

BY D. A. ALLAN, P.F.S.

I visited this valley for the first time this month, the reason being that some Chins who had settled in the valley after having given the Deputy Commissioner to understand that they were going to take to permanent cultivation, had resorted to their usual method of 'taungya.'

This valley starts somewhere about the middle of the Pakokku district, and runs to about half way up the length of the Upper Chindwin where it joins on to the Kabaw valley which continues through the rest of the Upper Chindwin district. The two valleys practically form one as the country separating them is more or less level, their average width is about eight miles and they lie along the foot of the Chin hills.

Parts of the valley reminded me of the Dehra Dun which is a valley lying between the Himalaya and the Siwalik range.

I was at once struck with the possibilities of these valleys.

A great part of them, I should rather say the greater portion of them, is fit for permanent cultivation being well watered by the streams which run down from the hills on both sides.

In the Chin hills close by there are numerous places suitable for hill stations which, with the opening out of decent roads, would make this one of the nicest parts of Burma.

A railway starting from somewhere near Minbu could, I have no doubt, be constructed without much difficulty to join the railway in Manipur, thus connecting Burma with India. There is fairly good shooting to be had in the valley and on the hills on both sides—among other animals Saing, Bison, Sarau and Elephant. The country is unhealthy in the rains, but with the advent of the large number of settlers that would surely come down from Manipur if a railway were opened out this disadvantage would in time disappear.

The Myittha river and the Neyinsaya stream which drain the Kale valley are navigable for small country boats throughout the year for nearly the whole of their lengths, and are used by Messrs. The Bombay Burma Corporation to float out the teak cut by them in the Yaw and Myittha divisions, and are at present also used to bring out all the paddy that is grown in the valley.

The opening out of this part of the country would also mean the opening out of our forests, for the extraction of non-floating timbers such as Pyinkado and Thitya Ingyin, the former of which exists in large quantities and which, at present, for want of a local market is left to rot in the forests.

THE SAILING VESSEL "ARMENIA."

BY A. RODGER, O.B.E., I.F.S.

What is probably the largest sailing vessel ever built in India is now nearing completion on the Pazundaung Creek at Rangoon. Mr A. C. Martin, of the Eastern Shipbuilding Co., has kindly given me the following notes and the two photographs published herewith (Plates 8 and 9) The vessel will be built entirely of teak and will measure 200 feet by 38 feet by 18½ feet, with an estimated carrying capacity of 1,800 tons. The best teak is being employed, and the ship is inspected daily by Lloyd's surveyor. The plans were received at the end of August, work began early in September

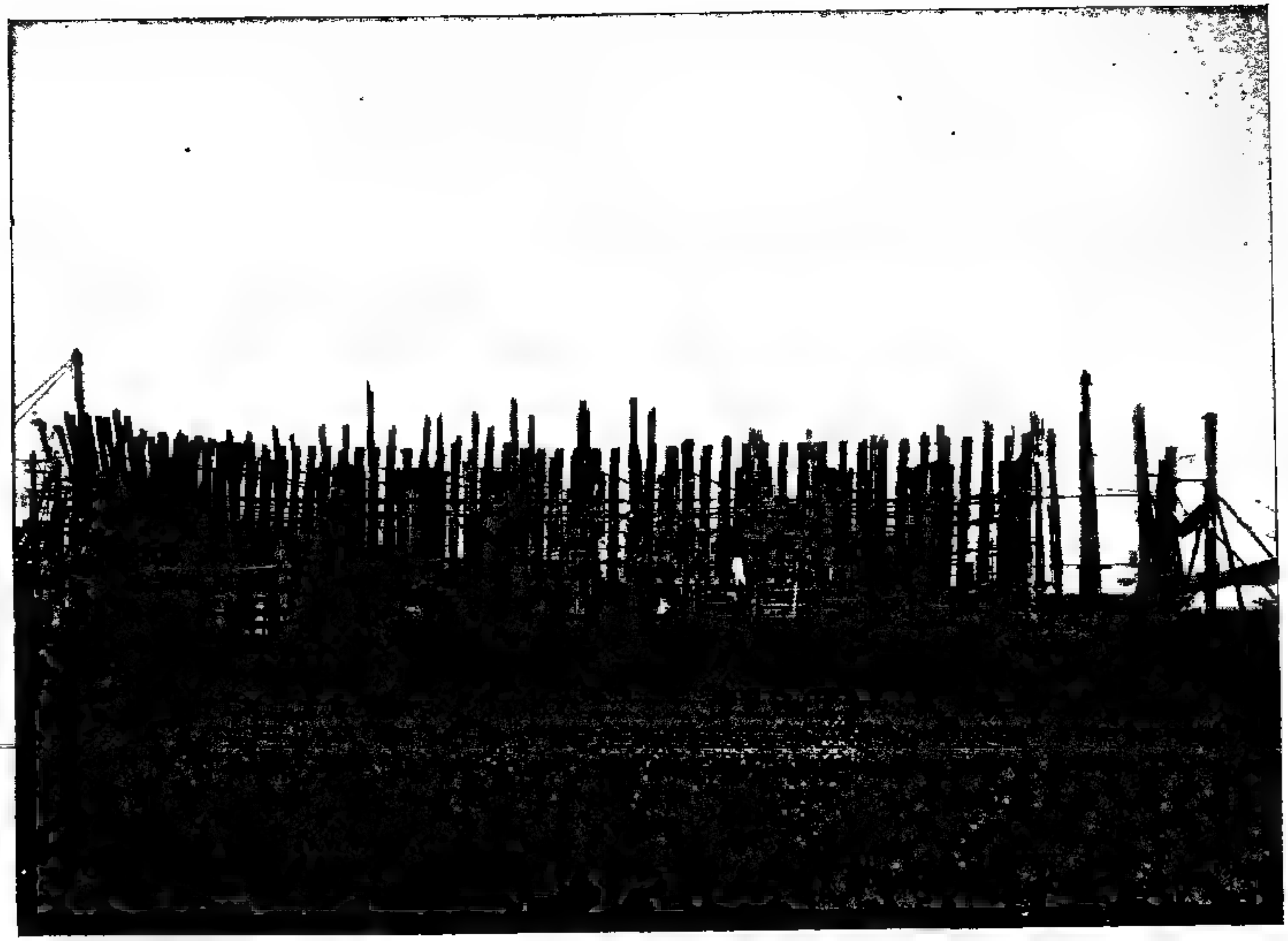


Photo.-Mechl. Dept., Thomason College, Roorkee.

THE SAILING VESSEL "ARMENIA".

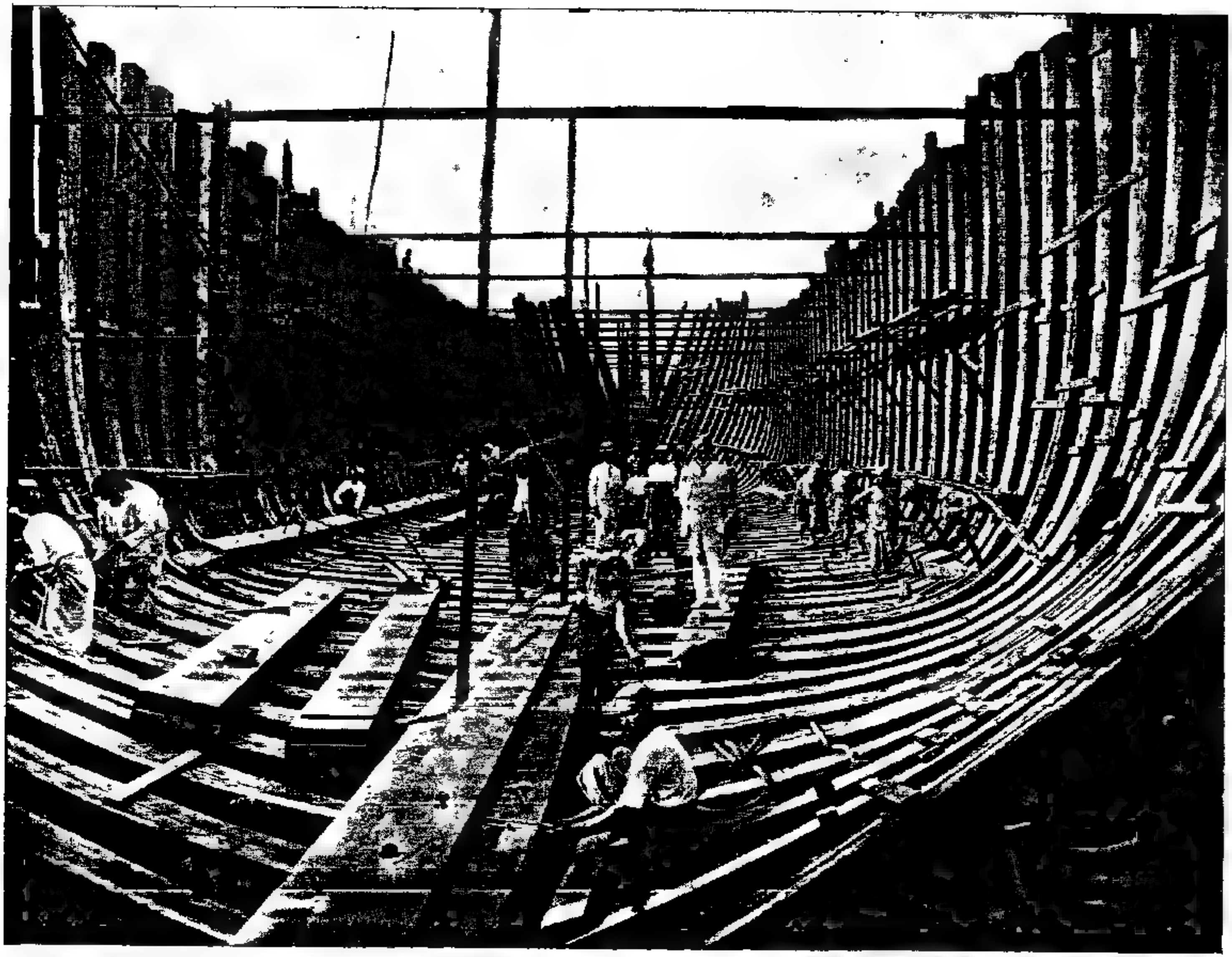


Photo. Mechl. Dept., Thomason College, Roorkee.

THE SAILING VESSEL "ARMENIA".

and the keel was laid at the beginning of October. The work is being carried out by Burmans. The photos were taken at the end of November. The vessel will be a motor auxiliary barquantine, built to carry a 175 horse power Semi-Diesel Oil Engine, which should give her a speed of 6 to 7 knots an hour. The masts will be *Hopea odorata* (Thingan) obtained in lengths of as much as 100 feet from the valley of the Bilin River, between the Sittang and the Salween. It is hoped to launch the vessel in February 1919, and her sister the "Ararat" will probably be launched in May 1919 Mr Martin is to be congratulated on the excellence of the work, and on his enterprise in building such fine vessels. It is hoped to publish another photograph at the time of launching.

EXTRACTS.

BUTTONS OF WOOD.

The wooden button industry in the United States has received a decided impetus, as a result of the activities of the Government in the prosecution of the war, according to a bulletin just issued by the United States Tariff Commission. The centre of this industry is in Providence, R. I., although some wooden buttons are being made in other New England cities.

Before the war the industry had an extensive foreign trade exports going to England, Germany, France, Belgium, Austria and South America. England was, perhaps, the largest customer

until shipments ceased, as a result of Great Britain placing an embargo on the enamelled wooden button.

White birch from the forests of New England provides the raw material for manufacturing those wooden buttons. The trees are cut in the winter and the logs are sawed at the mills into squares 4 ft. long, each side measuring from ½ in. to 4 in., the squares differing in sizes by 1-16th of an inch. They are seasoned or cured for about six months so that the wood may be worked into all shapes. At the factories these squares are known as "spool stock."

Wooden buttons are turned on special machinery adapted to the "spool stock" wood. The wood is shaped into button forms which pass through another special machine, which sandpapers them, and gives them a very smooth surface before they are enamelled.

There are, of course, all sorts of sizes, shapes and finish, buo the greatest quantities of small buttons are made from wood for use in laundries. Fancy wooden buttons are chiefly used on women's coats and suits or compete successfully with the same class of buttons made from other materials.—[*Timber Trades Journal.*]

AN INDIAN FORESTER'S EXPERIENCE.

Few Canadian foresters or fire rangers are called upon to pass through the experiences which the Indian Journal of Forestry credits to one of the British forest engineers.

The forester was visiting a clearing in a Sal forest, and with approving hand was patting the young Sal shoots, when raising his eyes, he saw a sambar within a few yards gazing hungrily at him. There being no tree handy, the forester didn't climb it. The officer ceased thinking of the girl he left behind him and concentrated his attention on the sambar. "Every now and then," he writes, "the sambar hammered the ground with his hoofs and his tail stuck up at right angles and looked as if it had been dabbed on as an afterthought." A sambar is savage at any time, but when he has a perpendicular tail, it is up to any human in the vicinity to prepare for immediate dissolution.

"Through a special intervention of Providence," continues the forest officer, "nothing happened." After looking me over for a little, the sambar lowered his danger signal and trotted off into the forest.

He had, I fancy, recognized the service uniform, but he wasn't after me. I am young and slender, while the chief is old and fat. Apparently it was the boss the brute was laying for.

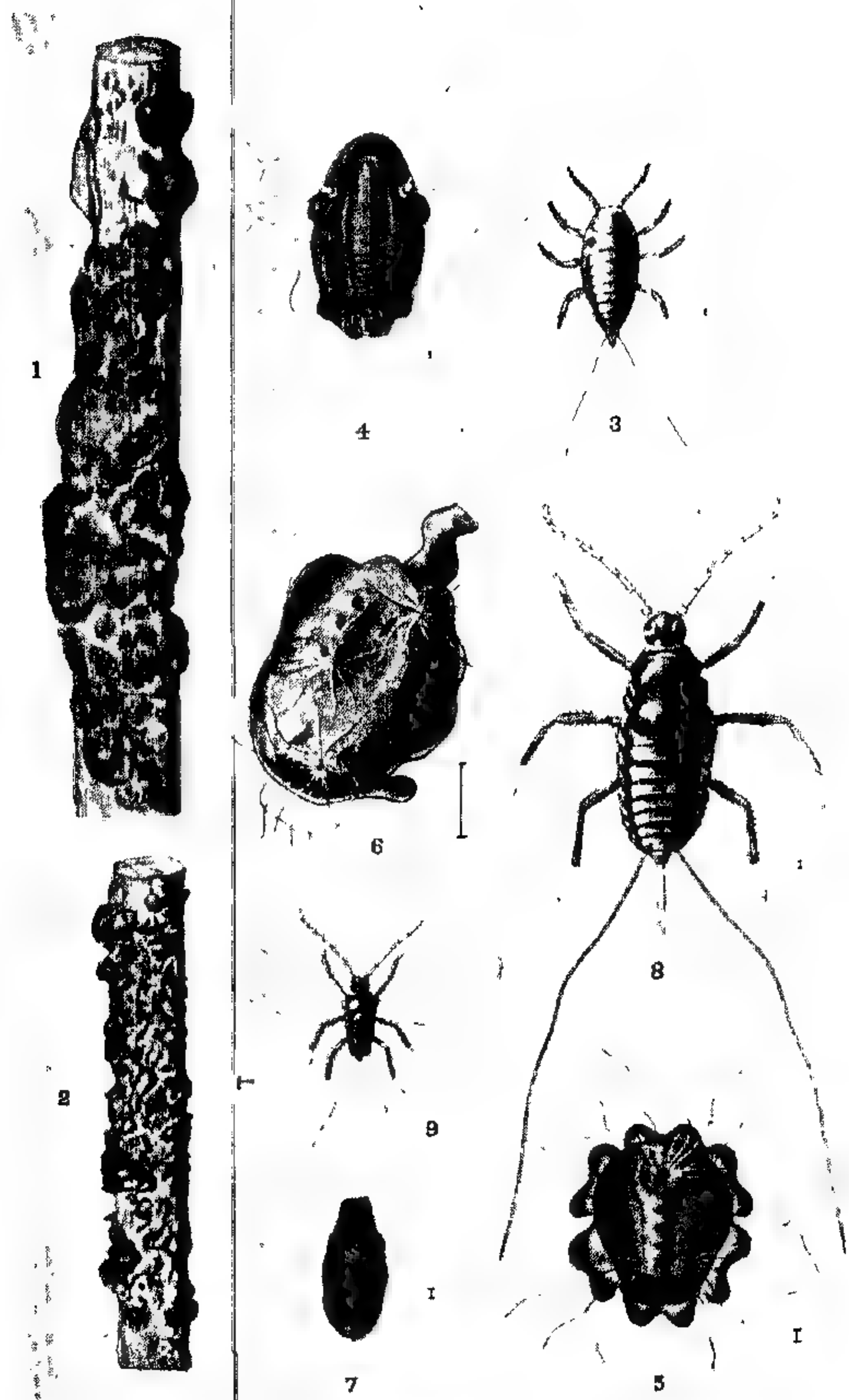
Plucking a handful of young Sal leaves the forester wiped the cold sweat from his brow, and turned to leave the clearing. He immediately found himself gazing into the blazing eyes of a man-eating tiger! The position was critical, and the forester again deeply deplored the absence of a climbable tree. The tiger's tail, like the sambar's, was in evidence. But the tiger's afterthought wasn't perpendicular. It was vigorously swished from side to side, and was playing the deuce with the young Sals within its reach. The officer opened his coat to get out pencil and paper wherewith to write a few last words, when—but let the forester tell his own story—"The tiger, I am of opinion, misunderstood my action. He thought, apparently, that I was about to give him a copy of the new forest orders dealing with the destruction of man-eaters, for, with a snarl of rage, he bounded off into the forest." The intrepid man was saved! The story of the adventure concludes with these moving words: "I reached my camp and took out a bottle of Scotch. I do not mind confessing that my hand shook as I poured myself out a first-mate's nip."—[*Canadian Forestry Journal.*].

THE PRESENT CONDITION OF LAC CULTIVATION IN THE PLAINS OF INDIA.

BY C. S. MISRA, B.A., FIRST ASSISTANT TO THE IMPERIAL ENTOMOLOGIST, PUSA.

At a time when every mind is busy with schemes of development, when every effort alike of experts and industrialists is employed on doing something to improve the general and economic condition of the poorer classes, no excuse should be needed for calling attention to an industry which is as old established as it is

PLATE X.



TACHARDIA LACCA.

[Reproduced from the Agricultural Journal of India by kind permission of the Agricultural Adviser to the Govt. of India, Pusa.]

EXPLANATION OF PLATE X.

Fig. 1. Healthy insects on stick.
" 2. Unhealthy " " "
" 3. Young lac insect. × 40.
" 4 A female 4 weeks old. × 35.
" 5. " 13 " × 15.
" 6. Young lac insects emerging from a female cell. × 4.
" 7. Male cell, 13 weeks old. × 12.
" 8. Wingless male. × 12.
" 9. Winged male. × 40.

important. From time immemorial it has formed the means of livelihood of thousands, if not millions, of the poorer classes of India, especially the aborigines inhabiting the outskirts of forests and such other areas where the hosts of the lac insect abound. That lac is a resinous secretion produced by an insect which sucks the juice of plants and transforms it into resin which surrounds it completely may not be known to some readers of this Journal. The secretion comes out of the epidermis of the insect which on exposure hardens into a deep red or orange-coloured substance, semi-transparent and hard, breaking with crystalline fracture. The insect belongs to a group commonly known as scale insects. It is found growing spontaneously on a large number of trees. [*Bulletin No. 28, Pusa Agri. Res. Inst.* (Revised edition), page 2.] At the time of emergence the young insect is one-twenty-fifth of an inch long deep red in colour, with three pairs of legs, a pair of feelers, a small bent tube and a pair of thin hairs at the end of the body (Plate X, fig. 3). It is very sluggish in its movements and wanders about until it comes upon a suitable spot to fix itself. When once fixed it cannot be removed. After fixation it thrusts its beak into the tissues of the stem and begins sucking the juice. The sap thus taken into the body is greatly transformed and is given out uniformly through pores all over the body in the form of resin, which after a few days encases it completely. If the young insect is a female it remains fixed once for all. If a male it emerges twice a year either as a winged or wingless little creature (Plate X, figs. 8, 9), which after fertilizing the female dies. After fertilization the female develops fast. It takes in more sap, consequently exudes more resin and swells up (Plate X, fig. 6). The lac-bearing branches are then cut off and placed on trees having a sufficient number of succulent branches. When the young insects have swarmed out, the old lac-bearing branches are removed, the resinous encrustation scraped off with a knife, ground in a mill, soaked in water and washed. The pure animal resin thus obtained is mixed with colophony and orpiment, cooked over a slow fire and drawn out into thin sheets—commercially known as shellac.

Within the last decade the industry has passed through various vicissitudes. It has brought ruin to more than it has benefited, and the pity is that up to the present time the causes which have brought about such a state of affairs have not been well understood. No doubt, over-production and the consequent over-stocking of the Continental and the American markets have contributed to a large extent to the lowering of the prices of the crude material from which shellac is manufactured ultimately. The prices touched their lowest point a year after the breaking out of the present war and the manufacturers as well as the cultivators in the interior of the lac-growing tracts began to think seriously of either giving up the cultivation and manufacture of shellac entirely or limiting their outturns. In fact the prices for shellac had gone down so low—Rs. 22 a maund—that it was hardly worth while cultivating the lac. The cultivator could hardly recoup the cost of cultivation and was keenly on the look-out for something else to grow. The prices for the crude material, commercially known as stick-lac, continued to fall till July 1915, when fresh uses were found for shellac. Its export then was limited and it was declared a contraband of war. From that date prices began to rise. Manufacturers ceased to make forward transactions and the cultivators, knowing that the prices would rise, hung on to their stocks.

There was in the phraseology of the Stock Exchange "all-round briskness." The industry seemed to have taken a new lease of life. There were enquiries for more lac all round. The manufacturer was willing to advance money on the strength of the future crop and the hitherto neglected cultivator was the centre of attention, and he too in order to make the most of the favourable times spared no pains to collect every granule of lac wherever it could be found.

This state of affairs continued for some time, when with the steadying of prices of shellac the normal flow of the crude material again began. But in spite of all this, the actual cultivation of lac has remained as neglected as before. The experiences of 1906 and 1907 were again repeated. There was a general scramble to collect as much material as could possibly be

obtained from trees large and small. Fresh and not well thought-out schemes were launched immediately and are still being continued for extending the cultivation of lac in areas where no previous cultivation has been done and where the climatic conditions which are an important factor in the development and subsequent acclimatization of the lac insect are decidedly unfavourable.

This short note has been written to draw the attention of the people who have either started the cultivation or are contemplating doing so in the future One remarkable thing in the stimulus afforded by the present abnormal rise in prices is that a large number of persons have already either actually started cultivation or are definitely thinking of starting it in localities where success is very doubtful, and that fewer attempts have been made in localities which at present practically meet three-fourths of the demand of the world.

During the past fourteen years I have been watching closely the trend of events, and I think it is much better to concentrate attention on improving the local methods of cultivation and storage in localities where the industry has been in existence for centuries rather than to start cultivation in localities where success is doubtful and where the moral effect of the failures is bound to act as a set-back to the budding industrialist.

As has already been stated by me in a note put before the President of the Indian Industrial Commission when he visited Pusa in November 1916, *India is the only country in the world* which supplies the market with shellac in its various manufactured forms, and in consequence the usual efforts have been and are being made by other countries to capture this monopoly. For the last few years the Japanese have been trying to grow lac in Formosa on *Schleichera trijuga* which abounds in the island and *kusumb** brood-lac was despatched from Pusa in crates especially made for the purpose. The plants were first potted in wooden boxes of special design to facilitate transport and, when these were

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* *Schleichera trijuga.*

established, they were inoculated with ***kusumb*** brood-lac and sent down to Calcutta in charge of a fieldman two months ahead of the swarming of the young lac insects. The Germans tried to experiment with lac cultivation at Amani in German East Africa. For this purpose Dr. Morstaadt took a small consignment of *ber* * brood-lac when he visited this Institute nine years ago. Some *Zizyphus jujuba* brood-lac was also taken by Dr. L. H. Gough, Entomologist Department of Agriculture, Egypt, when he visited Pusa in 1912 in connection with the introduction of Cotton Bollworms (*Earias fabia* and *Earias insulana*) parasites into Egypt. But so far nothing is known definitely as regards the success or otherwise of these experiments. It is therefore all the more necessary to put the industry on a sound basis by organizing the cultivation on scientific lines and in consonance with the present market requirements, and to eliminate such factors as introduce an element of uncertainty into the whole business.

In years when the prices rise, as was the case from 1905 to 1907 and again during 1915 and 1916, attempts are made to oust the natural product from the market with a synthetic material. But the attempts prove abortive, as the constituents of the synthetic product either cannot be obtained in bulk or the cost of manufacturing it leaves very little margin of profit to the manufacturer wherewith to push on its sale and to popularize it among the consumers of the natural product. These are some of the factors which militate against the production of the synthetic product on a commercial scale. In the country itself the short-sighted manufacturers, eager to take full advantage of the temporary rise in prices, adulterate the natural product. In fact during years of inflated prices, the proportion of the natural product—commercially known as seed-lac—in the manufactured samples of shellac is so low that it requires great care and judgment to discriminate the pure from the adulterated product. It therefore behoves every manufacturer of shellac to stop adulteration and concentrate on the manufacture of a standard article which will be of such

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* *Zizyphus jujuba.*

excellence as to effectually debar the synthetic product from competing,

A few years ago we tried to find out the reason of the partiality shown by the consumers for shellac, which even in its standard form is more or less adulterated with foreign ingredients such as colophony and orpiment, over seed-lac which is a pure animal product and in which the impurities can be easily detected. With this object in view samples of stick-lac produced at Pusa were ground in a hand mill to a standard size of grain. These were then soaked and washed with water—as per details given in *Bulletin No. 28, Agricultural Research Institute, Pusa* (Revised edition), page 20. But before the last washing was given Monohydrated Sodium Carbonate at the rate of 8 oz. to a maund (80 lb.) was added. The alkali was mixed thoroughly with the hand in the churning vats and when the desired softness was felt water was added and strained through wire-gauze sieves of graded meshes. The washed material was aerated in the shade and was frequently turned over to dehydrate it completely. This was repeated daily until the resultant product was a beautiful pale brown in colour considerably superior to the seed-lac obtained without the addition of the alkali. The treated samples were sent to Messrs. Parsons & Keith, London, and their report on the samples sent is quoted below *in extenso* :—

			REMARKS.
Kusumb (Schleichera trijuga).	Untreated ..	45s. per cwt. =Rs. 24-11-3 a md. (82 lb.)	Good quality, only a limited sale
	Treated ...	85s. per cwt. =Rs. 46-10-9 a md. (82 lb.)	Very fine, bold clean seed-lac. We have not seen any as good as this before here. There would be a good ready sale if the price could compete with fine orange shellac and Karachi seed-lac. In Karachi there is a fairly large business done, but this quality would be preferred by buyers.
Palas (Butea frondosa).	Untreated ...	35s. per cwt. =Rs. 19-3-6 per md.	Small stick-lac, not very saleable.
	Treated ...	75s. per cwt. =Rs. 41-2-11 per md.	Good quality, pale seed-lac, rather small. The same remarks apply to this.

* * * * * *

" Before speaking with absolute certainty, we shall have to test the samples marked 'treated' to see that they are saleable,

but judged by their appearance buyers seem to be taken with the treated samples, especially the Kusumb. This class of lac has only been shipped here in small quantities so far from Mirzapore, and it occasionally fetches a high price for special purposes. To be sold in large quantities it would have to compete with shellac and the price would vary with the price of shellac.

"We believe the treated would meet with a ready market and would fetch, roughly speaking, double the price of the untreated. Based on the present price of shellac, we think you could safely reckon to sell the Kusumb treated in quantity at 85s. per cwt., and the Palas treated at 75s. per cwt. We should recommend a trial shipment of 20 to 25 bags of each quality."

From further trials made at Pusa it was found that if a larger quantity of Monohydrate Sodium Carbonate than that stated above was added or if the alkali was allowed to remain in contact with the animal resin for more than 5 to 10 minutes, the natural wax surrounding the grain of lac was washed away and the resultant product was rather rough and crisp to the feel. From figures obtained through the courtesy of Messrs. Moran & Co., Brokers, Calcutta, the total quantity of shellac exported from Calcutta during the past twelve years, 1905 – 1916, was :—

	Cases.	Weight in maunds (80 lb.)	Price per md.			Total value.		
			Rs.	A.	P.	Rs.	A.	P.
1905	157,536	339,840	87	0	0	32,264,080	0	0
1906	156,502	301,255	107	0	0	41,864,285	0	0
1907	206,789	516,972	102	0	0	52,731,144	0	0
1908	222,112	555,280	57	8	0	31,928,600	0	0
1909	322,006	805,015	37	8	0	30,188,062	8	0
1910	289,996	724,990	40	8	0	29,362,095	0	0
1911	235,339	588,347	37	0	0	21,768,839	0	0
1912	254,141	635,352	34	0	0	21,919,644	0	0
1913	191,993	479,982	46	0	0	22,062,842	0	0
1914	231,831	579,627	35	8	0	20,576,568	8	0
1915	243,502	608,755	34	0	0	20,697,670	0	0
1916	236,681	591,702	55	0	0	32,543,610	0	0
		6,817,117				357,907,530	0	0

Thus on an average over five and a half lakhs of maunds of shellac worth about three crores of rupees have been sent out yearly from the port of Calcutta alone. Had similar figures been obtainable for the ports of Bombay and Karachi it would have been found that over seven lakhs of maunds of shellac, worth over four crores of rupees, must have been exported from the country annually. Had this quantity been treated as already described above, there would have been a net saving of thirty to thirty-five lakhs of rupees besides yielding a large quantity of lac-dye which might have been standardized to a paste to facilitate transport and to yield a colouring matter which, with proper mordants, might have produced from light to fast colours.

At the present time when the prices of shellac are oscillating to such an extent, with a general tendency to rise, as will be seen from the weekly quotations taken from Messrs. Moran & Co.'s weekly shellac reports,* it would be worth while sending trial shipments of seed-lac treated as noted above. In the beginning the new brand may be expected to meet with some opposition, as trade prejudices, however peculiarly they might have become grafted in practice, die hard; but if the quality of the new brand be maintained at a uniform standard, it is expected that the consumers would gradually take to it and would give up the use of the shellac in its present adulterated forms. This change would do away with the necessity of storing stick-lac in bulk and thus allowing it to get "blocky" or "coagulated." And this is not a small item as every manufacturer would testify from

*	T. N.	Superfine.
9th January 1918	92	120
16th " "	91-92	120
23rd " "	92-92/8	120
30th " "	93-96	120
6th February "	93-96	120
13th " "	93-96	120
20th " "	97-98	125
27th " "	97-99	125
6th March "	97-99	125
13th " "	99-101	125
20th " "	100-102	125

his bitter personal experience as to the cost of storing the stick-lac in bulk and preventing it from getting spoiled by insects which feed exclusively on the stored material irrespective of those which spoil the produce on the trees. No doubt, with a little attention to details, this loss can be prevented easily by clearing the godowns annually and fumigating them either with carbon bisulphide (vide *Bulletin No. 28, Agricultural Research Institute, Pusa,* Appendix C) or with flowers of sulphur at the rate of 4 lb. per 1,000 c.ft. of space. Before fumigating, the godowns should be cleaned thoroughly and no stray lumps of worm-eaten blocky-lac should be allowed to lie about the interior. All old burrows, pits in the floor, and crevices in the walls should be plastered over and the doors and the windows made airtight as far as possible. The weighed quantity of sulphur should then be placed in the rooms in earthen pans containing water to catch the overflow and the mass ignited. Doors and windows should then be closed and allowed to remain so for 24 hours, when they may be opened to let in fresh air.

In order that a sufficient quantity of stick-lac should be readily available in the market, it will be necessary to improve the method of cultivation practised in the different parts of the country. Prior to 1908 when lac-dye was a marketable item of considerable importance it paid the cultivator as well as the manufacturer to pay for stick-lac which was rich in colouring matter. But now with the introduction and extensive use of aniline and other dyes, lac-dye has sunk into insignificance and is not of much commercial importance. With this change in the market the cultivator has not kept himself in touch. He still follows the old antiquated system of removing lac before swarming has taken place. This, though it does not directly benefit him now, is at the bottom of the shortage in the supply of the crude material, and in spite of the prolific growth of the lac insect it has not been able to hold its own against the increase of parasites, predators and other factors which restrict its growth. It is therefore but proper that steps should be taken to remedy these defects and to bring home to the cultivator that it no longer pays either him or the

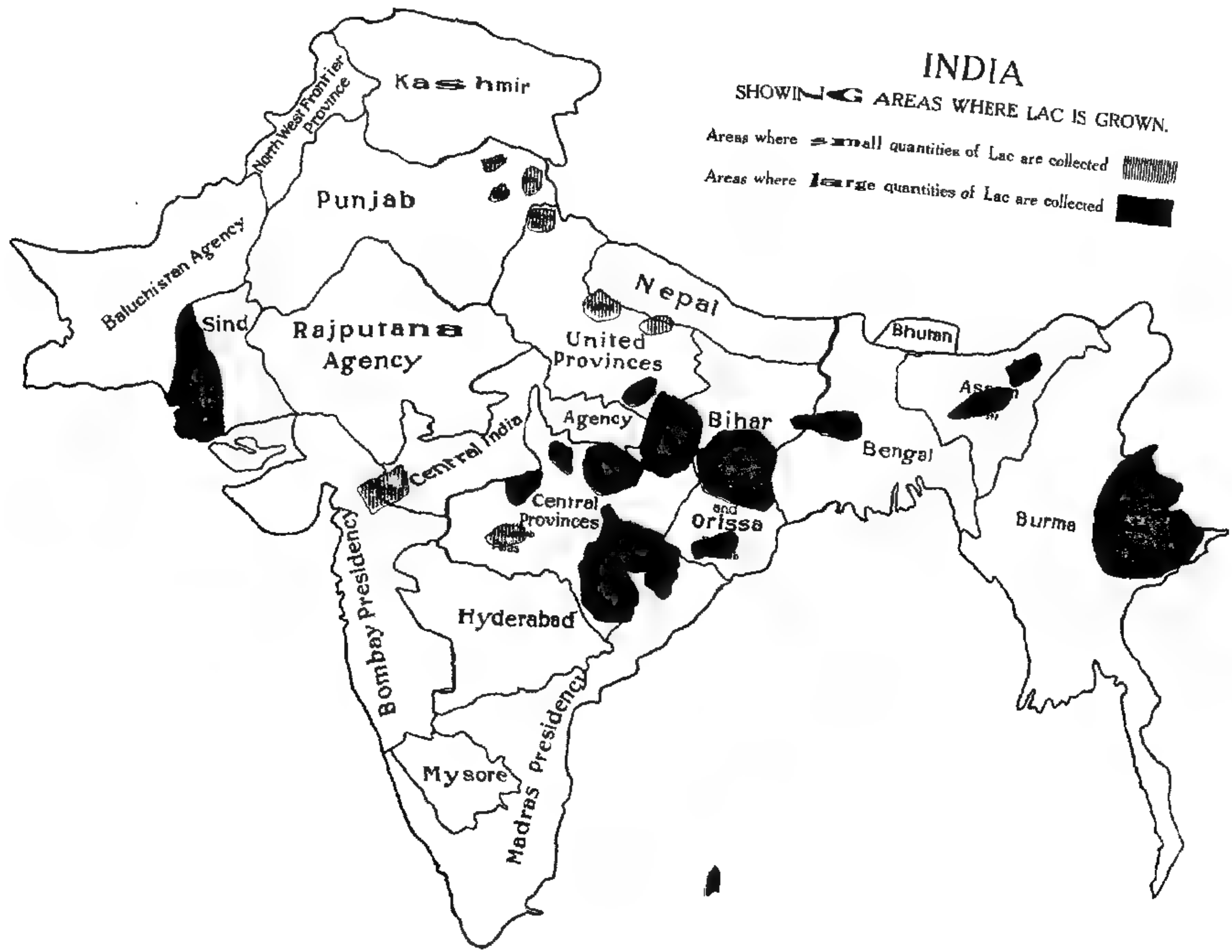
manufacturer to collect lac rich in colouring matter. This can be avoided easily by removing all the lac from the trees a fortnight before the swarming takes place and putting it on trees already pruned for the purpose. The *ber* and the *palas** stand pruning well and with judicious and seasonable pruning their life and vitality could be increased considerably—the pruning may be utilized either for charcoal making or for fencing cattle enclosures. Our experience for the past fourteen years shows that the produce from pruned trees is richer in resinous contents than that obtained from unpruned trees and that the successive broods reared on pruned trees are not so liable to disease as is otherwise the case. The present is a very opportune time to bring about these changes in the methods of cultivation, as with the high prices prevailing for shellac and in proportion for stick-lac for the last three years the cultivator has been able to recoup the losses sustained prior to 1915 and can well afford to spend a fair portion of his profits in renovating the trees either by pruning them or by making fresh plantations divided into blocks for the yearly and systematic production of lac. Besides this, he should also see that only healthy brood-lac is brought and put on the trees. This he can do easily by consulting the Plates XIII and XIV, in *Bulletin No. 28, Agricultural Research Institute, Pusa* (English and Hindi editions). He should also avoid bringing or purchasing brood-lac from localities where parasites and predators are present in large numbers and thereby running the risk of introducing them into new localities. Once these are established it is not only difficult but also expensive to eradicate them effectually. He should also arrange for occasional exchanges. Brood-lac from hilly tracts is more vigorous than that grown in the plains from year to year. While purchasing he should also see that the brood-lac which he wishes to put on his trees is obtained from a locality or localities where the climatic conditions are as similar as possible to those obtaining in his place. It is no good obtaining brood-lac from the borders of Nepal and experimenting with it at Allahabad or Gwalior. Such

* *Butea frondosa.*

trials are bound to end in failure, and should, as far as possible, be avoided. Further, it is much better to use *palas* brood-lac on *palas*, *ber* on *ber*, *kusumb* on *kusumb*, and brood-lac from Ficus species on Ficus species. Though *kusumb* brood-lac is the hardest of all, yet from further observations it has been found that it is from business considerations safer to abide by the amended note given above.

At present the distribution of lac cultivation in India is practically as shown in the map. In Sind the lac insect flourishes best on the *babul* (*Acacia arabica*), and over three-fourths of the quantity collected and exported from Karachi is obtained from this source. *Palas* lac is mostly obtained in parts of the United Provinces, Bihar and Orissa including Mourbhanj, Central India, Rewah, Nagode, and Maihar, the northern and the south-eastern parts of the Central Provinces, some parts of Bengal and Bombay —Panch Mahals, Ali Rajpur and Deogad. *Ber* lac grows spontaneously in the Punjab and is cultivated at Rungpur, Murshidabad and Dumkah in Bengal, and Manbhum in Bihar and Orissa. *Kusumb* lac is obtained in bulk from the Chota Nagpur Plateau and the Chhattisgarh Division in the Central Provinces, though it is more or less collected in almost all the lac-producing tracts in India. Large quantities of lac on Ficus species are obtained from Assam, where it is also grown in the Garo and the Khasi Hills on *mirimah*—a variety of *tur* (*Cajanus indicus*).

With such diversity in the food plants of the lac insect, much difficulty has been experienced in the past in obtaining healthy brood-lac at proper times for starting cultivations or making trials as regards the suitability or otherwise of the lac insect in new localities. The cultivators have hitherto neglected this source of income. The prices for the brood-lac and the subsequent transport charges have been so exorbitant in the past that it has not paid at all to start cultivation in new localities. If, however, suitable distributing centres are established in favourable localities, new areas—hitherto of no economic use to their owners—will be tapped yielding large and fairly constant quantities of stick-lac



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which will have the effect of steadying the prices of shellac if other factors remain normal. By the establishment of such nurseries vast areas overrun with *palas*, especially in the United Provinces, Central India, the Central Provinces, and Bihar and Orissa, will become productive and will benefit directly the rural population of such areas. For the present the establishment of a dozen nurseries distributed as follows would be ample:—

Sind	2 nurseries.	For the supply of *babul* brood-lac.
Central India .. .	2 ,,	For the supply of *palas* and *kusumb* brood lac.
Bombay ...	1 nursery	
C. P. and Berar...	2 nurseries.	
Bihar and Orissa	2 ,,	
United Provinces .	2 ,,	
Bengal .	1 nursery.	For *ber* brood-lac.

By some such arrangement the difficulties of transport would be considerably lessened, and the growers would have the assurance of obtaining healthy brood-lac at the proper time and at reasonable prices.—[*Reprinted from the Agricultural Journal of India, Vol. XIII, Part III.*]

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FOREST POLICY IN BURMA.

BY H. C. WALKER, I.F.S.

When acquiring land for the purpose of forming State forest reserves, it has hitherto been the practice to exclude all land from which villagers have been accustomed to obtain their requirements of forest produce. This practice appears to have originated in the belief that villagers possessed rights over the land and forest growth in the vicinity of their villages. Thus, in his "Forestry in British India," Mr. Ribbentrop, a former Inspector-General of Forests, stated that "though the Oriental Governments, from which the British Government inherited its forest property, never recognised a prescriptive right, it had to be admitted that, under the system originally in vogue, and which had remained entirely unchecked for some time after the British occupation, rights of user had, in some instances, been acquired by the legal process of prescription, in consequence of the substitution, or at least admixture, of Western laws and ideas, in cases where it had been exercised neither by force nor secretly, but fully openly, and unchecked, for 62 years."

For this reason, and possibly also for reasons of policy, great care was taken not to prejudice the interests of villagers by reservation. It was taken as a matter of course that the boundaries of a proposed reserve should be thrown back three or four miles in order to leave a large forest area for the use of even a small village of about 20 houses. As an instance of the policy adopted, in the Tharrawaddy division two or three villages of Karens were found situated in the heart of some of the finest teak forests in Burma. There were only about half a dozen houses in each village, and in those days there was ample land available for shifting cultivation outside the proposed reserve, but instead of removing these villages, or almost allotting to them the smallest possible area compatible with their needs, a large area, amounting, I believe, to several square miles per family, was specially demarcated out for them within the reserve.

In some cases, generally in order to obtain a more satisfactory boundary along a natural feature, it was found necessary to bring the boundary of a proposed reserve so close to a village as to include land of use to the villagers; and, in such cases, definite rights of extraction to be exercised for all time were granted under the Settlements.

It seems very doubtful, however, whether villagers had ever legally acquired definite rights of user as suggested. The usual method of acquiring land in Burma is merely to bring it under cultivation for field crops; and, in such cases, the cultivator removes the forest growth, however indispensable it may be, and regardless of the fact that villagers have, from time immemorial, been accustomed to obtain their requirements from the area. In any case, Government does not appear to have recognised such rights, but immediately after the conquest of Pegu issued a notification, dated the 26th September 1853, declaring all forest lands to be the property of Government and proceeded to exercise its authority as owner. For instance, although cultivators had, from time immemorial, been accustomed to fell immature Pyinkado trees and to utilize the timber as house-posts and for making ploughs, Government prohibited the felling of this tree without license. Again,

Government reserved to itself the right to issue to traders licenses for the extraction of any forest produce, however indispensable it might be to cultivators. On the other hand, in the Rule prohibiting the felling of trees on waste land, provision was made that any villager might freely extract timber of the unreserved kinds within 10 miles of his village for domestic, agricultural or piscatorial purposes. This does not however, necessarily imply the admission of a right, but appears to be merely a concession which can be modified or cancelled at any time.

I am not a legal expert, but nevertheless am inclined to the opinion that the grant of permanent rights in reserves is unnecessary. It is only reasonable that no village should suffer by reservation, but in cases where it is necessary to bring a reserve boundary close to a village, I think it would suffice to exclude sufficient land capable, under intensive management, of satisfying the requirements of the villagers, and in addition to grant temporary privileges in respect of forest produce within the reserve so as to place the village on an equality with villages more remote from the reserve. Hitherto the rights granted have caused no inconvenience, but experience in more advanced countries proves that rights granted, at a time when a country is undeveloped, gradually become an unmitigated nuisance.

The principal field crop of the country is paddy, and there is, therefore, a natural tendency for population to gravitate into the plains. There have always been a certain number of people, however, who, by choice, or because they have not the capital for permanent cultivation, earn their livelihood by shifting cultivation. Except in the case of hill tribes, there is a tendency for these people to keep in touch with the larger villages in the plains, and to congregate into the foothills leaving the main watersheds untouched. The policy of excluding all villages and of leaving them an ample amount of land has, therefore, not prevented the Forest Department acquiring a very valuable estate, comprising large compact blocks of forest admirably suited for economical methods of management.

Until recently, our energies have been concentrated on the organization of our teak forests, which includes examination of

areas with a view to reservation, settlement, demarcation, survey, and valuation for the purpose of framing working-plans. Although this work is practically completed, there remains a vast amount of work to be done in developing these forests and in improving the growing stock. Even in the finest teak forests there is only a thin sprinkling of teak in a jungle of unmarketable rubbish. At present our teak forests yield only about half a crore of rupees, or possibly less, whereas eventually they should yield at least ten crores of rupees; but to obtain the highest possible production will be a very gradual process, and will involve an enormous amount of work. Moreover, there appears to be a world shortage of timber, and it seems practically certain that when conditions become normal, it will be possible to export, at a profit, large quantities of timber of species such as In (*Dipterocarpus tuberculosus*). This species tends to form pure forests, easy to work, and is found on laterite or gravelly soils, unsuited to field crops, and as I understand that large compact blocks of forests of this species could be acquired without affecting the interest of villagers, these areas should, therefore, be reserved and exploited. There are also prospects of developing a large trade in Pyinkado for railway sleepers, mangrove bark for tannin, bamboo for paper-pulp and inferior timbers for distillation.

It has been suggested that the Forest Department should take steps to reserve all land unsuited for field crops; but, in my opinion, such a policy would only result in the neglect of existing reserves, and I think most Forest Officers must admit that, even if we adhere to our present policy of excluding the more accessible lands from which villagers and traders are accustomed to obtain their requirements, and, on the other hand, the more inaccessible lands or lands covered with inferior and unmarketable tree-growth, there is sufficient work in sight to occupy the whole of the energies of the existing staff or of any conceivable increase of establishment which is likely to be sanctioned for many years

It is necessary, however, to consider the question from an entirely different point of view, and to take into account the question of local requirements. In the early days of British Rule

there appears to have been ample forest produce for every one. For instance, even in the plains, there appears to have been a considerable amount of virgin forest, as is proved by the fact that even under the policy adopted the Forest Department was able to acquire, free of right, blocks of forest, such as the Rangoon Plains forest, covered with virgin forest, although the land was suitable for paddy cultivation. Our predecessors had, therefore, little need to study the question of local requirements. The people had always been accustomed to fell timber how and where they liked, and to have interfered with this custom would have caused friction at a time when it was particularly desirable to cultivate pleasant relations with the people and to inspire a spirit of confidence. Since those palmy days, conditions have changed very considerably. In the first place, the rapid extension of cultivation has reduced the area under forest growth, and the resultant increase of population has enhanced the demands on the remaining area. Further, with more settled conditions, the standard of comfort has increased with the result that the consumption of timber per head is greater than formerly. In addition, villagers and traders continually pick out the more valuable species in the best and straightest stems, and thus there is a steady and constant force at work making for the survival of the unfit.

There is a natural tendency to underestimate the deterioration of the unclassed forests. Land not actually under cultivation, even near large towns and villages, is usually covered with dense vegetation of sorts, and the average European does not concern himself with the value thereof. He may not know what species are subject to rapid decay, or difficult, and almost impossible to work; and whether stems are branched or crooked is to him a matter of indifference, the process of deterioration has also been obscured by the increasing wealth of the country. As one forest becomes exhausted, all that has happened is that traders have gone further afield, and the resulting increase of prices has been met by a greater ability to pay. The fact that in Burma enormous areas are covered with forest and that teak can be profitably worked even from the most remote forests is apt to create the impression

that, if necessary, other species could be worked out. Teak is, however, worked out by elephants, the supply of which is limited. It floats when dry, and commands a very high price owing to special qualities. Timber is very difficult to transport and, therefore, the whole question turns on accessibility so long as there is an adequate supply of good timber close at hand, prices are low, and every one is very happy, but with a steadily increasing population and with every trader and villager striving to obtain the best timber he can from the most accessible forests, these forests become exhausted and are never given a chance to recover. The next most accessible forests are then attacked, and these are in turn exhausted. Meantime the cost of timber steadily increases, and it is obvious that, if the process is allowed to continue unchecked, prices will go on steadily rising, until eventually, although there is ample land available, the cost of timber will become almost prohibitive.

The danger seems to be fully recognized—at least by forest officers and I believe the proposal that all land not fit for the production of field crops, and in fact fit for nothing but forest crops, should be reserved, has been put forward as a remedy for the steadily increasing deterioration of unclassed forests. Most forest officers, during their course of practical training in Germany, have seen an occasional village forest of which the nett profits have been handed over to the villagers, but the management left entirely with the State Forest Officers; and, I think, the idea underlying the proposal is that similar village forests should be formed, by acquiring small tracts of forest for each village and by regulating the yield under the working-plan, the Forest Department doing everything while the villagers look on. In Germany, however, there are very few village forests, certainly not more than one on the average for each forest officer, whereas in Burma there are hundreds of villages in each division and ample land available. Hitherto in acquiring land for reservation, we have only taken up land of no use to any one, and have supported our proposals by somewhat rough sketches, except where the area borders on a village. The reservation of land in the foothills, honeycombed

with villages, would obviously be a very much more difficult proposition. Up to date, *i.e.*, in the last forty years or so, we have only reserved an area of under 30,000 square miles, whereas the area of waste land, practically the whole of which is unfit for field crops, is over 140,000 square miles.

Reservation would alone be a large undertaking. Settlement and demarcation would also be difficult. Hitherto our working-plans have been fairly simple (but incidentally somewhat expensive) as only one species has been considered, and compartments have been made of large size. The requirements of villagers are various—fuel, bamboos, house-posts, timber for dugouts and for house building—and the quantities required annually for each village comparatively small, and altogether a working-plan would be complicated, and as thousands of small plans would be required the operation would take many years.

In my opinion, therefore, the formation of village forests on the lines of German village forests is impracticable, and it is significant that, although many years ago special rules were framed for village forests and included in the Forest Act, as yet not a single village forest has been formed. In forming any opinion on the question, I think it essential to take into consideration the question of finance, and on this account any scheme which entails a large and expensive establishment must be ruled out of the question. Even at present the staff maintained to protect the unclassed forests is financed to a great extent out of our revenue from the teak reserves, and I would deprecate any further diversion of funds which are urgently required for the development of the reserves. Another point to which, I do not think, sufficient attention has been paid is the feelings of the villagers themselves. In every country the people are accustomed freely to help themselves to the wild products of nature. Even in England the natives pick wild products, such as mushrooms and black berries, even for trade purposes, without applying for permission, and regard it as a sort of right In Burma the people have always been accustomed to fell timber, how and where they liked, and even if the Forest Department prepared a working plan for a patch of jungle, I doubt

whether the villagers could be induced to observe the provisions, although to their interests to do so. Another point which has to be considered is that in many of the more accessible forests, where the demands are very great, there remains little timber of any value to be protected or regulated.

My own opinions have been greatly influenced by my experience at Mawlaik, a new head-quarter station. A considerable amount of tree-growth had to be cleared away for sites for houses and offices and at the same time there was a great demand for timber for house-building, but practically none of the trees felled could be utilized for this purpose. Many of them were of fair size, and the jungle did not appear to have been heavily cut over, but the trees were of unsuitable species, or of bad shape, or otherwise incapable of yielding useful logs. On the other hand, I have recently had an opportunity to see some interesting experiments in the Katha division and in particular was greatly impressed by the fine growth of Yemane (*Gmelina arborea*) in a plantation a mile or so from the railway line. This species is in great demand by villagers and has been almost exterminated in many unclassed forests. It is of very rapid growth and is said to attain marketable dimensions in about 40 years, and as the cost of forming such plantations is only two or three rupees an acre, the profits will be very great.

The question arises, therefore, whether villagers could not be induced to plant up waste lands with valuable species of trees such as Yemane. It must be admitted that hitherto they have not shown any ardent desire to do so, but they themselves admit that they lack initiative and they have no experience of conditions in developed countries. On the other hand, they seem to respond readily to suggestions by District Officers in whom they have confidence. I have seen it stated, but cannot find the reference, that in one district a large number of bamboo groves were formed near villages merely as a result of a keen Deputy Commissioner impressing on villagers the advantage they would gain by doing so. Throughout the Chindwin there is a net-work of roads made by villagers at the suggestion of District Officers. The villagers

receive no pay for the work, but turn out annually in a body and clear the roads half way to the next village. The success of the war loan is another instance of the influence of Deputy Commissioners, and I think it by no means improbable that in the congested areas where the scarcity of forest produce is being acutely felt, villagers could be induced to plant up waste lands near their villages.

I would further suggest that the provision in the Forest Manual allowing villagers to extract unreserved timber without payment within 10 miles of their village should be cancelled or modified, by restricting free extraction to the village tract. The present restriction is very arbitrary, as it is often cheaper to extract timber 100 miles to go down a river, than to drag it a very short distance across difficult country, and the restriction is difficult to enforce. By modifying the rule, it would bring home to villagers the fact that they cannot expect always to get a free supply of timber, and would, therefore, encourage reclamation of waste lands I consider also that the village tract would form the only possible basis of any scheme of village forests and would suggest the object to be aimed at, is to induce every village to plant up all the waste lands within the village tracts.

In modifying the rule, I would suggest conferring on villagers the privilege of exacting felling fees, subject to a maximum of, say, Rs. 1-8-0 a tree, from other villagers who require timber for their own use and not for trade. The effect, therefore, would be to abolish the 10-mile restriction so far as the Forest Department was concerned, and incidentally make it clear to the villagers that the object of modifying the rule was not to squeeze more revenue out of the people. At the same time, I think villagers should be given to understand that any revenue received on this account should be spent on planting up waste lands. When making teak plantations, the Forest Department utilizes the services of taungya cutters and pays them a small sum for sowing teak with their main crop; and my object in making this suggestion is to create for villagers a small source of income which could be utilized for financing a similar policy. After all there is a certain amount of

reasonableness in requiring outsiders who want forest produce to pay for the cost of measures to protect the future supply.

A further question which naturally suggests itself is whether in congested areas taungya cutters could not be prohibited from cutting taungyas, except on the condition that a tree crop is sown with their main crop. If, at the same time, they received a reasonable payment from the village community, little hardship would be caused. At present taungya cutters do a considerable amount of injury; but, in this way, they would become useful to the general welfare of the country, and might gradually develop into woodsmen and earn their livelihood by felling and logging timber and replanting the areas cleared.

The amount of waste land in a village tract unfit for field crops, but suited for forest crops, is unequal, and usually varies in inverse proportion to the population. At the same time, the distribution is not inequitable; and, generally speaking, it seems desirable that the poorer villages with little first class paddy land should cater for the requirements of the more prosperous villages. There is, however, ample land for everyone; and, if necessary, the Collector could either alter the boundaries of a village tract, or allot a tract of land to any enterprising municipality or village community on the condition that the area be planted up within a given period. Similarly, if the Forest Department wished to acquire accessible, and therefore valuable, land for the production of fuel for locomotives or steam launches, I would suggest that, instead of acquiring land by the process of reservation, the land should be gradually acquired by reclamation, in the meantime both villagers and the department being allowed to obtain their requirements from the waste land on equal terms. This would cause little friction and would avoid the troublesome question of settlement.

I have already suggested that any restriction on produce extracted by villagers for their own use should be enforced not by the Forest Department, but by the villagers themselves. Government would still be the owner of all forest produce and would retain the right to sell any timber to traders under a system of licenses, and I would further suggest that the village headmen

should be held responsible for protecting the interests of Government, and for supervising the work of licensees. At the same time, I would make it worth his while by authorizing him to exact felling fees The felling fees could be fixed at, say, four annas or over eight annas a tree, payable by the licensee. For this fee the headman would be required to prevent any trader felling timber within his village tract without license, to prevent undersized trees being felled, and to insist on logs and stumps being marked with the traders' property mark. On completion of the work, he would be required to endorse the license with the number of trees felled and logs obtained. It would not be necessary for the headman to watch every tree being felled. In many cases, the villagers themselves do the felling and logging for traders, and he could find out from them whether the rules were being observed. The Forest Department could then reduce the number of beat officers, or rather utilize the services of these subordinates for purely forest work in the reserves, only maintaining a small staff along the rivers and railways for assessing timber extracted for royalty.

Land from which mature timber could be extracted to the market at a cost of Rs. 5 a ton is obviously of great potential value as compared with land from which timber could not possibly be extracted at a cost of less than Rs. 20 a ton. Generally speaking, the land which the Forest Department has reserved is of very low value for the reason that under the policy adopted we have not taken up the more accessible land from which villagers and traders obtain their requirements. For the most part, the reserves consist of large compact blocks of forests on the main watershed, the majority of which could not be worked except by elephants, or wire rope-ways, or except opened out by a costly scheme of roads or tramways. It is inconceivable that such forests could be properly managed, except by the State and by a trained and qualified staff At the same time, although the land is of little value the growing stock is often of considerable value owing to the natural protection it has received on account of its inaccessibility For instance, in the Upper Chindwin there are two blocks of reserves under working-plans comprising 497 square miles.

These forests are quite inaccessible either for traders or villagers, and yet Government has derived from them for the last four years an average annual revenue of Rs. 5,57,667, or roughly a lakh per 100 square miles. The amount spent on improving the growing stock, including the cost of fire protection which is of doubtful advantage, only amounts to Rs. 13,772 a year. It is evident, therefore, that the process of development has hardly begun. I maintain, therefore, that the Forest Department should concentrate its energies on developing reserves such as these ; and, incidentally, I would observe that I think the policy for these areas is not reclamation, which involves the destruction of existing crop, but restriction of the yield to the natural production, and improvement of the growing stock by the removal of worthless species, more especially where these are suppressing and killing valuable species.

On the other hand, land from which villagers and traders obtain their requirements is comparatively of great potential value. Naturally, when everyone is allowed to fell timber, how and where he likes, the most accessible areas are the most heavily worked over, and therefore the greater the potential value of the land the less valuable is the growing stock For the most part the land is honeycombed with cultivation ; and although the total area of land unfit for field crops is very great, the land available is often found in small patches with no natural features as boundaries. Such land is most unsuitable for management by the State, but excellently suited for management by village communities for the production of timber for their own requirements. In such cases, in my opinion, the most practical policy is to encourage and, if necessary, insist on reclamation. Villagers regard with indifference forest growth being destroyed by traders or outsiders by taungya cutters or by cultivators wishing to plant field crops, but would oppose the enclosure of forest land by the forest officer and the regulation of the yield, and therefore it is a policy of the least resistance. The troublesome and expensive questions of examination, settlement and demarcation are entirely avoided. The expense of forming these plantations would be very small, the

highest possible results per acre would be obtained, and where the land is close to the market and the timber exploitable by cart, the profits would be very great. Such plantations would naturally be classed as village forests, for which special rules would have to be framed to protect the crop from traders and outsiders.

Such forests would be quite distinct from unclassed forests, and each year the village forests could be gradually extended, until all the waste lands in the tract had been reclaimed. At first a working-plan would not be necessary, but when all the waste land had been reclaimed, a simple felling scheme could be drawn up and would present no difficulty. By a village forest is usually meant one which is formed to satisfy the requirements of the village, but in Burma, I think, we should attempt more than this, and encourage the more jungly villagers to cater for the requirements of the larger villages in the plains which have no waste lands suitable for reclamation. There is no risk of flooding the market as any surplus of valuable timber such as Yemane, Thitya, Ingyin, Pyinkado, Kanyin, etc., would be readily absorbed by the Indian and European markets.

Provided villagers could be induced to undertake the formation of plantations and thus ensure the future supply, I think it would be a pleasing act to relax the rules in respect of unclassed forests. I would merely retain the duties on timber extracted for trade purposes and would abolish all royalties on minor forest produce, firewood and charcoal These taxes are troublesome to collect, and I do not think the loss of revenue would be great—probably far less than that caused by abandoning the system of extraction contract in favour of purchase contract in the case of teak—and there would be some saving of expenditure by reduction of establishment. Incidentally, the tax on firewood might be reimposed by municipalities as an octroi in order to finance a municipal scheme of reclamation. I would even, if possible, abolish sawpit licenses and removal passes, but would be in favour of registration of sales of timber so that every purchaser could produce a bill to prove that his timber had been lawfully extracted.

I have also suggested that if possible village headman should be induced to accept the responsibility of protecting Government's interests by exercising supervision over extraction by traders. In this case it would be desirable to simplify the license system, and instead of specifying the number of tons of timber to be extracted, to authorize up to a stated numbe rof trees to be felled. Village headmen on the whole seem to be quite as trustworthy as forest guards, and it seems to me satisfactory to make payment according to the amount of work done than to pay a monthly rate.

It necessarily follows from my proposals that I am in favour of the control of the unclassed forests being vested in the Deputy Commissioner, not only nominally but actually. The state of the unclassed forests and the future supply of timber for local requirements is a matter which affects the general welfare of the people very intimately, and therefore concerns the Deputy Commissioner; and, at the same time, it is a matter which requires little technical ability, and for that reason is not of great interest to forest officers. The Deputy Commissioner is the father and mother of the humble villagers, and he alone has the necessary authority and influence to ensure the success of a comprehensive scheme of reclamation. Assuming also that village headman could be required to exercise supervision over the work of licensees, it is the Deputy Commissioner alone, who could take action against any headman who failed to carry out his duties. However, beyond using his influence I do not think the Deputy Commissioner could reasonably be expected to undertake onerous duties but, as is usual, when any tedious and uninteresting work has to be carried out, such duties would be left to the assistant, which humble, but highly useful job would be filled by the Divisional Forest Officer. The latter would maintain a staff principally along the rivers or railways for the assessment of timber and check in transit. He would also, during the slack season, visit the jungly villagers, and examine the counterfoils of receipts issued by headman for felling trees and compare them with his license registers or trader's accounts.

In conclusion, I would point out that about sixty per cent. of the land in Burma appears to be fit for nothing but forest crops,

and, therefore, if the wealth of the Province is to be increased, it will be mainly by developing the mineral and forest resources. As regards the latter, it is, I think, generally admitted that the more assessible, and therefore more valuable, forest lands, are being gradually impoverished ; and that although the country abounds in forest produce, villagers and townsfolk are paying steadily increasing prices for their requirements and, therefore, I think it high time that a more forward policy was adopted.

FELLING.

BY H. W. BICKNELL (MESSRS. SPEDDING & CO.), KULU.

There is but one method of felling which seems to have been generally accepted and practised, and this is faulty and does not serve well the purpose for which it is intended. This consists in making two cuts in a tree, one about 6 or 8" higher than the other; the lower cut, on the side the tree is intended to fall, is carried through two-thirds of the girth, and the upper cut, from the opposite side, is made parallel to it. In this connection several theories have been advanced which are based on principles too fanciful to be of practical value. Thus Government have insisted in their leases that all trees shall be felled uphill, never considering that the weight lies downhill; the tendency of a tree grown on a hillside is to throw out branches towards the light, that is, on the downhill side of the bole, and even to lean itself in that direction, the upper side being darkened, either by the hill itself or by growth standing at a higher level. Thus the tendency is for the tree to fall downhill, and it is particularly difficult, and often impossible to make it fall uphill even by the use of strong wire cables. This is because the tree, so long as it is uncut, is too strong and rigid to bend, and before the fibres have been cut through sufficiently the weight will have started an opposite downhill pull; while once the tree has commenced to fall, no power on earth will keep it back. At the commencement of felling the tree is already inclined several degrees downhill from the vertical, and this may perhaps be put right when it is cut through and made movable if the weight

already lying on the downhill side does not forestall the pull of the cable.

I have ignored the above generally accepted rules, and have adopted what I consider to be the best method, and can claim a fair amount of success for it, having got 98 to 99 per cent. of trees to go where I wanted them, and this with many thousands of trees.

The simplest and quickest method, which labour finds easy, will always be best when large fellings are to be carried out, and I have always made this my rule. I have used saws and wedges and do not care for them; as they furnish no help, I cannot obtain by other and quicker means. Felling with the saw will never be of use on a mountain side owing to the difficulty of reaching a tree from the lower side, thus rendering it possible to saw through from the upper side only, whereas an axe can be swung round quite a long distance, from where the axeman must stand, and the cut can be carried in any direction. A saw is much slower and more tedious and gets badly pinched. Unless the roundness is cut away from the bole on the side opposite to the saw, the whole weight of the tree has to be raised and upset over a small semi circular edge, rendering the tree liable to turn over to either side, whilst the work has to be carried on against the weight the whole while. It is, moreover, difficult to get the wedges in properly; and if they are too small, or get crushed, the tree will balance on its stool, and swing round in any direction, causing danger to the feller; or a gust of wind catching the top will easily upset it in a wrong direction. If it is necessary to cut out a V-shape, so as to bring the fulcrum to the centre of the bole, thereby lessening the work on the levers or wedges, and also obtaining assistance from the weight, then why not do it by the quickest means?

The loosing of a large gang of wild, jungly axemen in a forest, under what is supposed to be the control of one man, is about the worst thing that could happen. I remember, when first starting felling in the Kishenganga valley some years ago, I employed a gang of coolies who had worked for the D. F. O., and said they knew all about felling. They first stood round whilst the mate said a prayer or "dewar," as he called it; then a wild hacking took

place, and soon great giants were toppling in all directions, breaking into pieces as they crashed. I asked where a tree was likely to fall, and was told "Allaha jana.' One just missed me, scattering a fire I had been warming myself at, whilst another fell on one of my Munshis, who fortunately came up unhurt through the branches. Damage to the standing crop and to the trees themselves was more than I could allow to continue, and it has been my custom ever since to employ 10 or 20 men in charge of a Munshi and Chaprasi who thoroughly understand their job. Each feller is taught his work before he is allowed to go on with it, and not more then one new man may be taken on at a time, nor the number allowed to exceed the maximum of 20. This causes delay and extends the work over many months, but ensures careful work, much saving of timber, and protection to standing trees. The Munshi has to point out to each man the direction in which the tree is required to be felled, and see that he cuts it correctly, being assisted by his Chaprasi. He keeps a register in which he writes the number of the tree, the name of the felling cooly, and notes if the tree has been correctly felled and the direction of its fall; if it has fallen contrariwise, he is to explain why it happened. He also notes if a tree was branched or roped. This register is constantly inspected by one of my assistants or myself, and this exercises a great check on Munshis shirking work, and sitting preparing false reports in their "daras" instead of going into the forest. An amusing instance of a Munshi so given to preparing his reports from numbers cut off stumps and brought down to him at his "dara" by felling coolies occurred when he reported having branched a number of trees, which the Conservator, on inspection, found had been branched with all the axe cuts made from below upwards. As this could not happen whilst the trees were standing, they must have been branched after felling, the Munshi, having been round and seen the damage his negligence had caused to the regeneration, had adopted this insufficiently ingenious means of protecting himself.

When deciding in which direction a tree is to be felled, the Munshi makes a careful inspection of it to ascertain to which side

it leans, and he will then direct it towards the nearest gap on that side. A tree will go as much as 45 degrees away to either side from the direction towards which it leans, that is, the uncut fibres are strong enough to hold the weight, whilst the equilibrium is disturbed in another direction, and I have always found room enough to put it somewhere between these 90 degrees without doing damage. When a Munshi is in doubt he must also rope it which ensures success. The direction of the fall having been decided upon, the feller will cut level on that side to about three-fourth the way through, or even more with a big tree, and proportionately less with a smaller one (Plate 11, Fig. 1). This is in order to carry the cut as far back as possible so as to throw forward the maximum weight, while preserving a sufficiently long ridge of fibres or uncut wood to hold the tree from going over sideways. The larger your tree, the further can you afford to take back this edge of the unfinished cut and the more the equilibrium is disturbed in the desired direction. After the forward cut, which is also the lower one, has been completed, the feller starts on the opposite side, exactly in the middle of that part of the circumference which up to now has been left uncut, and works in level parallel to the first cut and about 4" to 6" above it (Fig. 1), so that, at the fall of the tree, there is left a narrow ridge of fibres, which are an even thickness throughout (Figs. 2 and 3). If the cuts have been correctly made and are parallel to one another, and the head of a T square is placed up against the edge of fibres in the lower cut, the arm or blade will point exactly in the direction in which the tree will fall.

The object of making one cut higher than the other is little understood. It is done so as to enable the lower cut to be carried in deeper than it could be done were both cuts of equal height up the bole, and at the same time to retain a sufficiently strong ridge of fibres to guide the fall. The stool being higher on the side of the small cut, braces and supports the fibres, and renders an upward and lengthwise pull necessary to break them; but the tree, moving in the opposite direction, need not break them until it has swung several feet, and the fibres only separate and crack

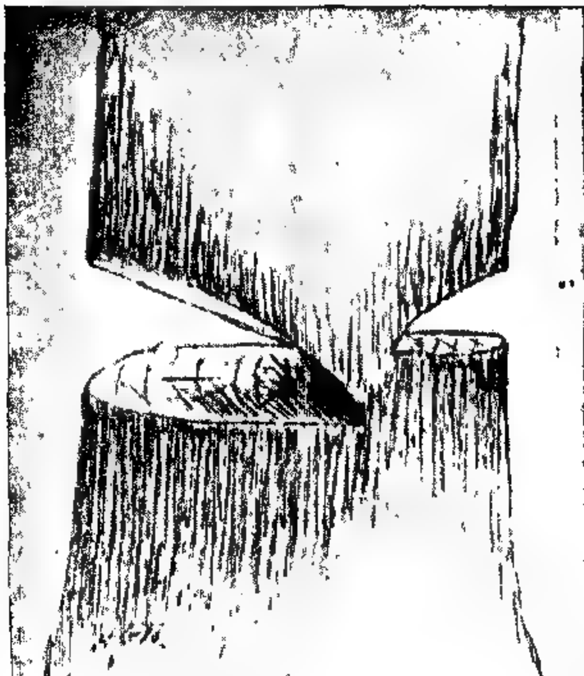


Fig. 1.

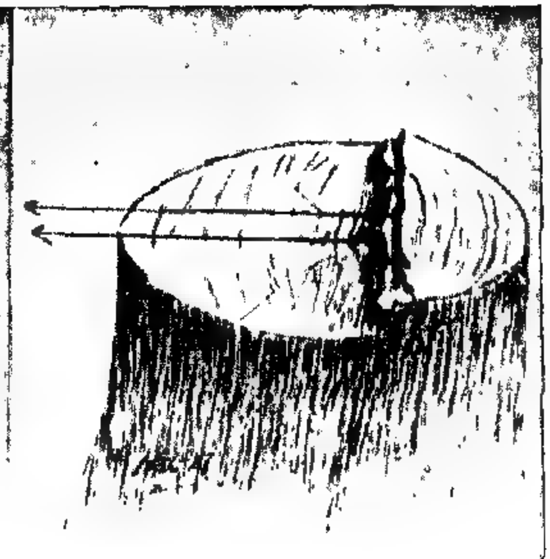


Fig. 2.

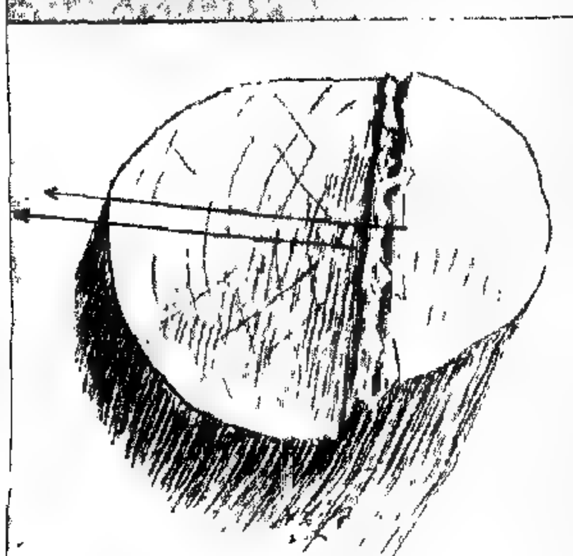


Fig. 3.

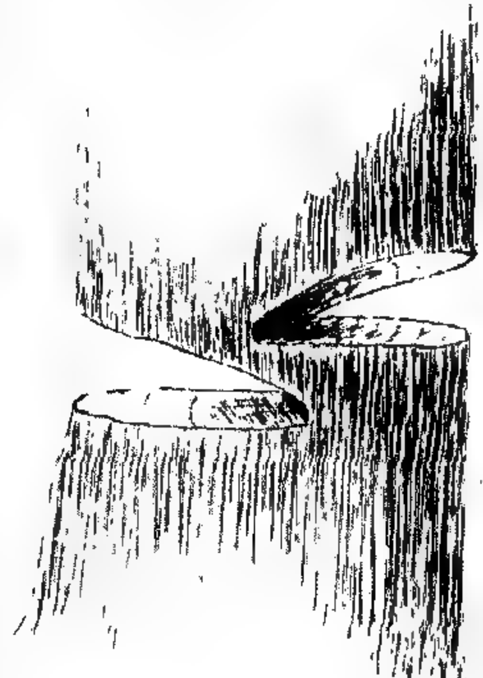
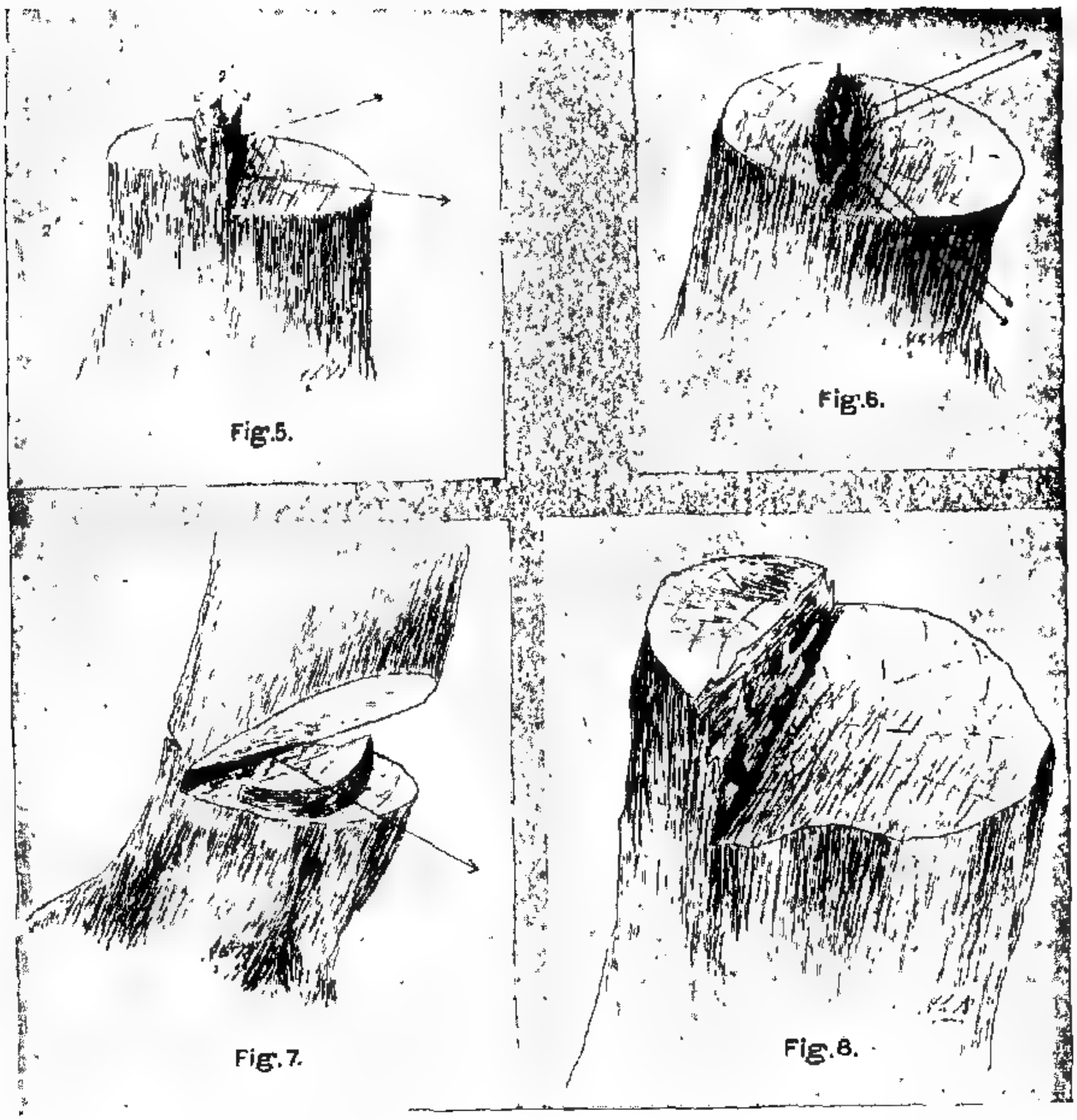


Fig. 4.

FELLING.



away from the higher level of the stool when the tree starts to move, which requires comparatively little strength. For instance, if a board be hinged to the floor and stood up against a box, it can only be pulled over the box with great difficulty and not at all without breaking either the hinges or the board; but a very slight touch will send it in the other direction. This is an exaggerated example of what happens in the case of the tree, but it exerts no small influence. If, on the other hand, the cut is made too high, it will be carried through too far, and will pass over parallel to the lower cut before the fibres break (Fig. 4), and the lower cut will have lost its use altogether; the weight now being thrown in the other direction, the tree will break at the upper cut. By cutting away the fibres underneath, the hinge has been destroyed and there is now no resistance to an upward pull.

If the two cuts have not been made parallel to one another and diverge at an angle, the tree is acting on two sets of hinges which direct it in different directions (Plate 12, Fig. 5); the one hinge may influence the tree to move due north, and the other 40 degrees away from it, and it consequently depends which of them is weaker, and breaks first, and the tree will not fall true. This is of great importance where there is a small gap with regeneration all round to protect. Similarly, if the cuts are made semi-circular (Fig. 6) there are hinges all round exercising divergent pulls, whilst the bulge of the rounded cut even acts as a wedge preventing the tree from falling in the desired direction, which it can only do when the cut is trimmed off straight (Fig. 7). It is a common fault to make the cuts curve outwards (*i.e.*, convex) on account of the difficulty of cutting in at the centre of the bole, whilst the sides are got at easily, and this requires particular care. I generally put my walking-stick up against the cuts to convince the feller of what is required. Making the cuts curve inwards (convex) would also be harmful, but it is difficult to do and the mistake seldom occurs. Another common error is to make the cuts slope away downhill, instead of keeping them perfectly level, and this requires constant correction (Fig. 8). This is caused by the weight of the axe drawing the hand down lower the further

it is swung from the body, while in making closer cuts the weight is not so great. The base of the tree is now placed on a slant on the fibres which are themselves slanting, and the tendency is that as the fibres snap when the tree commences to fall the butt will slip away on the downward slant of the stool, and alter the fall by several degrees.

I know I shall be severely criticized for condemning the saw and be told I am wasting 2 feet of timber; this economy is all very well with hardwood species grown on easy ground where the trees do not break up into several pieces on falling. A Deodar will break into fifty pieces and all splinter down so that there is no useful timber left. With care I can save with every tree felled many times what is lost by axing. It must be considered that I am felling trees with a bole of 100 to 120 ft. of useful, timber along hillsides of varying slope, on rocky broken ground, and I have, as far as possible, to make the bole strike the ground evenly throughout, to avoid breakage, as well as to protect the standing crop, and 1½ to 2 ft. is not much to sacrifice to these ends A tree falling downhill swings through nearly 160 degrees; the great speed gathered as it swings almost through half a circle causes it to take a big jump away from its stump before striking the ground, and it slides a long way downhill before it is checked, doing great damage on the way, and breaking itself into many pieces. Trees when felled in this direction can more easily reach the tops of other trees, and do them most damage, and putting them so should be avoided. Cross felling trees one over another will cause them to break and slip away downhill, as they can get no purchase on the hard sloping boles of those already fallen, and hence all trees should be felled so as to lie as far as possible in one direction.

ANALYSES OF SOME MORPHOLOGICAL CHARACTERS OF BOMBAY WOODY SPECIES FROM AN ŒCOLOGICAL STAND-POINT.

BY L. J. SEDGWICK, F.L.S., I.C.S.

The idea of this paper originated from a desire to test the "drip-tip" theory of Stahl. The impression left on the mind of any one who peruses the œcological text-books is that the leaves of the tropical evergreen species have in almost all cases very long *caudæ*. The stock instance is *Ficus religiosa*. The long apical *cauda* was regarded by Stahl as a means of draining off the water, and thus avoiding the clogging of the stomata. Stahl called this *cauda* a "drip-tip," while Jungner introduced the word "rain-leaves" to indicate the caudate-acuminate tropical leaf form. These theories savour of the ultra-Darwinian principle of finding, in every character, a definite and advantageous adaptation to environment. The possibility of accidental characters, neutral characters, and characters which are the effect of environment, but are of no functional value to the plant was lost sight of. Moreover the stock instance of the "drip-tip," *viz.*, *Ficus religiosa*, is a rather unfortunate one, since this tree occurs widely throughout India, and is believed to be wild in the sub-Himalayan and Central Indian forests, regions which are not constantly moist, nor even exceptionally moist for long periods. It is also very problematical whether a long *cauda* would materially facilitate the keeping open of the stomata. If the stomata were closed by a very fine film of moisture, as for instance in the case of a leaf with a microscopically rough surface, the *cauda* would be ineffectual since it could not drain off water held by capillarity. While if, as is usually the case with evergreen species, the surface of the leaf is extremely smooth, polished, and even waxy, then the water will run off, whatever the leaf apex, except so much as remains as isolated and rounded drops. It was consequently a matter of interest to me, when I first saw the Kanara evergreens, to find that the "drip-tip" is by no means a very pronounced feature of

the forest, and therefore evidently by no means a necessity to the evergreen tree. Lately, it occurred to me that it might be of interest to make an analysis of the leaf-apices of all the woody species in the Bombay Presidency, with a view to ascertaining what forms are most prevalent in the main œcological divisions. The Bombay forests fall fairly naturally into evergreen, deciduous, xerophytic and maritime. Along with evergreen, I have included such deciduous species as are confined to regions of heavy rainfall. By "deciduous" I imply only the true "monsoon-forest." The dry deciduous of Gujerat, Badami, Gokak, and the Satpuras I have classed as xerophytic. By "maritime" I imply only those species that are definitely littoral, and not those which are typical of coast forests above sea-level. For the purpose of the analysis I have used Talbot's Forest Flora. I have excluded all species that are merely woody herbs, such as the *Acanthaceæ* or semi-herbaceous twiners, such as many *Asclepiadaceæ* and *Papilionaceæ* as well as low river bed species such as the *Homonoias.* I have also excluded all those species which have pinnate or multi-pinnate leaves with very minute leaflets such as the *Acacias.* Species with compound leaves but large leaflets are included, the leaflets for the purpose of these analyses being treated as leaves, since they function as such. Only indigenous species are considered.

Pari passu with the analysis of leaf apices, I made analysis of armature and methods of seed dispersal. These will be separately discussed.

I. Leaf-apex.

The analysis was not at all easy to make. A considerable number of species are recorded as having a variable apex. Such expressions as "acute or acuminate," "acute or obtuse," "obtuse or shortly and obtusely acuminate" are of constant occurrence. It was also very hard to decide whether to allocate a species to my class "very long acuminate" or to the next "gradually acuminate." Generally speaking, "very long acuminate" means a long *cauda* from a fairly obtuse apex. *Ficus religiosa* is not included as it is not a native plant. In the second analysis the classification is wider, and the personal equation is therefore reduced.

The percentages of this analysis given in No. 3 are of interest. *While the very long "drip-tip" as a constant feature of moist* regions is not established, it is certainly established that a fine point to the leaf is a feature of such regions, while an obtuse apex is typical of the xerophytes and maritime (physiologically xerophytic) species. But, for my own part, I should hesitate to agree that this phenomenon had anything to do with the necessity of enhancing or reducing transpiration. The simplest explanation seems to be that an acuminate leaf-apex is only the result *of general good development owing to favourable conditions.* The nerves of the leaf are a continuation of the vascular bundles of the branches, and the acuminate leaf-apex would only mean that these ultimate vascular bundles develop in length in excess of the lateral development of the leaf-blade. Of the very obtuse species occurring in the moist forest several are *Bauhinias,* whose peculiar leaves are possibly relics of a type which, in early ages, was more frequent. An interesting case of obtuse leaves in evergreen is *Carallia integerrima,* DC. (*C. lucida,* Roxb., in Talbot F. F.). The fact that this inland mangrove has a noticeably obtuse leaf-apex seems to imply that it has moved in from the coast, rather than that the other members of the family have been driven out into their present habitat. Its leaves, however, are often shortly and bluntly acuminate, though even so they are in general outline noticeably different from those of the other species around it.

II. Armature.

For the purpose of this analysis, I included the species with very minute leaflets which had been excluded from the analysis of leaf-apices, though still excluding palms, herbaceous twiners and shrubby herbs, as above described. The numbers of armed and unarmed species is probably fairly accurate. And the percentage of armed to unarmed in the different formations is roughly what would have been expected, *viz.*, evergreen 9 per cent., deciduous 18 per cent, xerophytic 35·5 per cent. and maritime nil. The absence of armature from the maritime woody species is, however, rather interesting, since maritime herbs show a common

tendency to become spinous. In the matter of armature I feel that ultra-Darwinian views have again been pushed to an extreme. It is often said that the reason for so many armed species in the dry country is that only those species have survived which rendered themselves immune to herbivorous animals by developing thorns. This is of very doubtful validity. Goats habitually eat *Acacia arabica* whenever they can get it, in spite of its formidable thorns. Camels eat *Alhagi*. And I have myself seen a buffalo and her young calf burying their noses in *Spinifex*, than which nothing more formidable could be imagined. Nor have I noticed that monkeys show any disinclination to climb thorny trees. I have made a separate analysis of the details of the armature of the armed species. "Anomalous" includes mainly axillary and supra-axillary spines, the origin of which is obscure. The cases which I have classed as reduced branches in evergreen and deciduous are entirely in the genus *Flacourtia* which, as in the case of *Carallia* discussed above, suggests that *Flacourtia montana* and *F. latifolia*, Cooke, have moved into the moist region from the dry. Just as in the case of leaf-apex, so in the case of armature I feel that the phenomenon of thorns is simply due to the tendencies of general development. In the dry regions lignification and general rigidity of all parts is much more pronounced than in the moist. And the commonest organ in which this lignification sets in is the stipule. Next comes the hardening of the apex of the branchlet. This is very well seen in *Fluggea leucopyros*, *Gymnosporium montanum* and *Flacourtia sepiaria*, in which the so-called thorns continue to function as branchlets. Prickles are usually climbing apparatus, and are probably in origin developed from friction of the stem of the climber against its support. The anomalous thorns, very well seen in many of the *Rubiaceæ*, offer much greater difficulties.

III. SEED DISPERSAL.

The analysis which I have given of seed dispersal must be accepted with reserve, since the classification of mechanisms is even more difficult than that of leaf-apices. Probably a larger

number of the evergreen species have seeds adapted to carriage by water than I have shown. It was also almost impossible to decide which fruits are edible. As a matter of fact, I have given the benefit of the doubt in all cases to edibility. Those species which have dehiscent dry capsules with hard exarillate seeds, such as the majority of the *Euphorbiaceæ*, are put into the "unclassified" column, though there is no reason why they should not be eaten by birds. Again I was unable to segregate the "censer mechanism" of some authors, of which the *Aristolochias* would be a good example if their seeds were not also winged. The only percentage which it is perhaps worth taking is that of wind mechanisms (wings or pappus), the numbers for which to the total number of species gives evergreen 11·5 per cent., deciduous 17 per cent., xerophytic 19 per cent., maritime nil.

I. Analysis of Leaf-Apex.

No. 1.

	Number of species.	Very long acuminate.	Gradually acuminate.	Abruptly and usually obtusely acuminate.	Acute.	Sub obtuse.	Obtuse.	Very obtuse.	Plant leafless in mature states.
Evergreen ...	393	10	132	77	105	41	20	8	...
Deciduous ...	130	.	27	14	41	14	26	8	
Xerophytic	94		9	5	19	13	25	14	9
Maritime	28		3	4	4	4	1	2	.

No. 2. / No. 3. Percentages.

	Number of species.	Acute or acuminate	Sub-obtuse	Obtuse.	Acute or acuminate.	Sub-obtuse.	Obtuse.	Leafless.
Evergreen	393	324	41	28	83%	10%	7%	...
Deciduous	130	82	14	34	63%	11%	26%	
Xerophytic ..	94	33	13	39	35%	14%	41%	10%
Maritime	28	11	4	13	39%	14%	47%	

II. Analysis of Armature.

	Number of species.	Unarmed.	Armed.	Class of armature.			
				Prickles	Stipules.	Reduced branches.	Anomalous.
Evergreen	400	362	38	15	8	2	13
Deciduous	136	114	25	6	11	2	6
Xerophytic	108	69	39	5	18	7	9
Maritime -	28	28		.			.

III. Analysis of Seed Dispersal

	Number of species.	Water.	Wind.		Animals.				Unclassified.
		Floating or adapted to water.	Provided with wings.	Provided with hairs or pappus.	More or less edible.	Having bright arils.	Bright coloured without aril.	Provided with hooks.	
Evergreen .	400	3	30	17	271	25	8	3	43
Deciduous ..	136		24	9	88	4	4	2	5
Xerophytic .	108		11	9	71	3	2	1	11
Maritime ...	28	15	..	...	10		.	.	3

DEVELOPMENT OF LITTLE USED TIMBERS.

BY R. S. PEARSON, I.F.S.

One of the most important Utilization problems now to be solved is the best method of developing markets for timbers, other than those which find a ready sale. The subject falls under two distinct heads, *viz*:—(i) those timbers which are required for constructional and general purposes, and (ii) timbers employed for special purposes such as, for instance, rifle stocks, gun-carriages, turnery, tool-handles, carving, panelling, etc. By far the greater amount of timber will come under the first head, which will at the same time, generally speaking, fetch lower prices than that required for special purposes. The development of the markets for these two classes of timber must necessarily go on hand in hand, and if anything more attention should be paid to the former class, as the bulk of our output will be of that order. Of late, however, more attention has been paid to finding substitutes for European timbers for special purposes, and this was necessary under war conditions; then again it is a not unnatural tendency to aim at finding suitable timbers for special purposes, as if the interested person is successful, he quickly has the satisfaction of seeing some tangible result of his labours. We must, however, guard against the tendency to over specialize, and keep in view the main issue, namely, to find openings for the vast quantity of timber which will have to be placed on the market, as the working of our forests becomes more and more intense.

When attempting to place new species of timber on the market, the first point to be attended to is that it should be in a good condition and if converted, it should be of correct size, according to classes. This is, of course, well known by every Forester and Timber merchant; the difficulty is to ensure that it is so, as the District Forest Officer has little or no time to attend to such duties nor has he, in many cases, the necessary plant of proper design in which to cut up the logs. To add to the difficulties, many of our Indian timbers are difficult to season, and require special attention, which all means expense and time. To

overcome this difficulty, several Local Governments are appointing Utilization Officers, who will be in charge of the development of both major and minor produce they will also act as the Laison Officer between the Forest Officer and the Commercial World and translate result obtained by Research Officers into commercial propositions. It takes little imagination to realize the great importance of such Utilization Officers, or to realize that they too will soon find more work than they can well cope with, not to mention that the work of correctly cutting up, careful stacking and seasoning need not be carried out by so highly trained an officer.

To make the most of our timbers it will be necessary to convert them in properly equipped saw-mills, and to establish in connection with these saw-mills seasoning and storing depôts, in charge of a competent saw-mill manager. If such establishments are run by Government agency, they need not necessarily be large, and may only be of an experimental nature, chiefly aiming not so much at profit as in establishing markets for new varieties of timber, and storing timber against initial demand for special purposes. It has often been found that after favourable reports have been obtained on samples of timbers to be used for special purposes that the first large consignment has been a failure owing to there being no stocks in store and consequently unseasoned timber having to be sent, this means that a second order is not placed, and that a new market is not established.

In order to illustrate what may be done by careful seasoning, and also to show how timber may be damaged by incorrect methods, a few of the results obtained by carrying out a seasoning experiment are given below. The table illustrates the condition of the timber, when thoroughly seasoned, the percentages being based on the condition of each piece and by striking averages for a large number of specimens inspected.

Species.	Method of seasoning	Percentages. Sound	Badly cracked	Badly warped.	Insect attack.
Bassia latifolia .	Seasoned in the log immersed in water for four months, then seasoned on land, converted and seasoned in the plank Total period two years and six months	29	71	...	...
Do. do. .	Seasoned in the log without bark, under shade for 18 months and in the plank for 12 months	48	52	4	...
Do do. ...	As above, but with bark on	40	56	4	...
Do do.	Logs converted green, planks seasoned in the shade, weighted above to reduce warp, for two years and six months.	83	15	2	...
Bombax malabaricum	Logs immersed in still water for four months, dried for 13 months in the log, converted and planks seasoned in shed for three months.	..	53	...	Heavily attacked by borers.
Do. do. ..	As above, but in running water for four months	. .	75	...	Do.
Do. do. ...	Green logs converted into planks, then immersed in water for four weeks, and dried in shed for 19 months.	93	7	.	...
Do. do .	Seasoned in log for 17 months, converted and seasoned in the plank for three months.		44	.	Riddled by borers.
Do. do. ...	Green logs converted and planks seasoned in shed for 20 months.	...	60	..	Heavily attacked by borers.
Dillenia pentagyna	Seasoned in the log, in the open, for 18 months with bark off, converted and seasoned in the plank for 15 months	Both planks and rafters are rotten.			

Species.	Method of seasoning.	PERCENTAGES. Sound.	Badly cracked.	Badly warped.	Insect attack.
Dillenia pentagyna ..	Planks converted from green logs and seasoned in the open for two years and nine months.	Both planks and rafters all rotten.			
Do. do	Seasoned in the log and immersed in water for four months, on land for 14 months, converted and seasoned in the plank for 15 months	.	56	44	4
Do. do. ..	Trees girdled for 12 months, felled and converted into planks and seasoned for 21 months.	58	42	.	
Do. do. ...	Trees girdled for 30 months, felled and converted into planks and seasoned for three months.	97		.	..
Do. do .	Seasoned in the log with ends protected, in one case with Tar and in other with Loracine, for from 12 to 33 months and then converted.	Both planks and rafters all rotten			

Note :—In such cases where the various columns do not total to 100 per cent. the planks or rafters are either both badly cracked and attacked by insect, or are cracked and warped or a combination of all these defects.

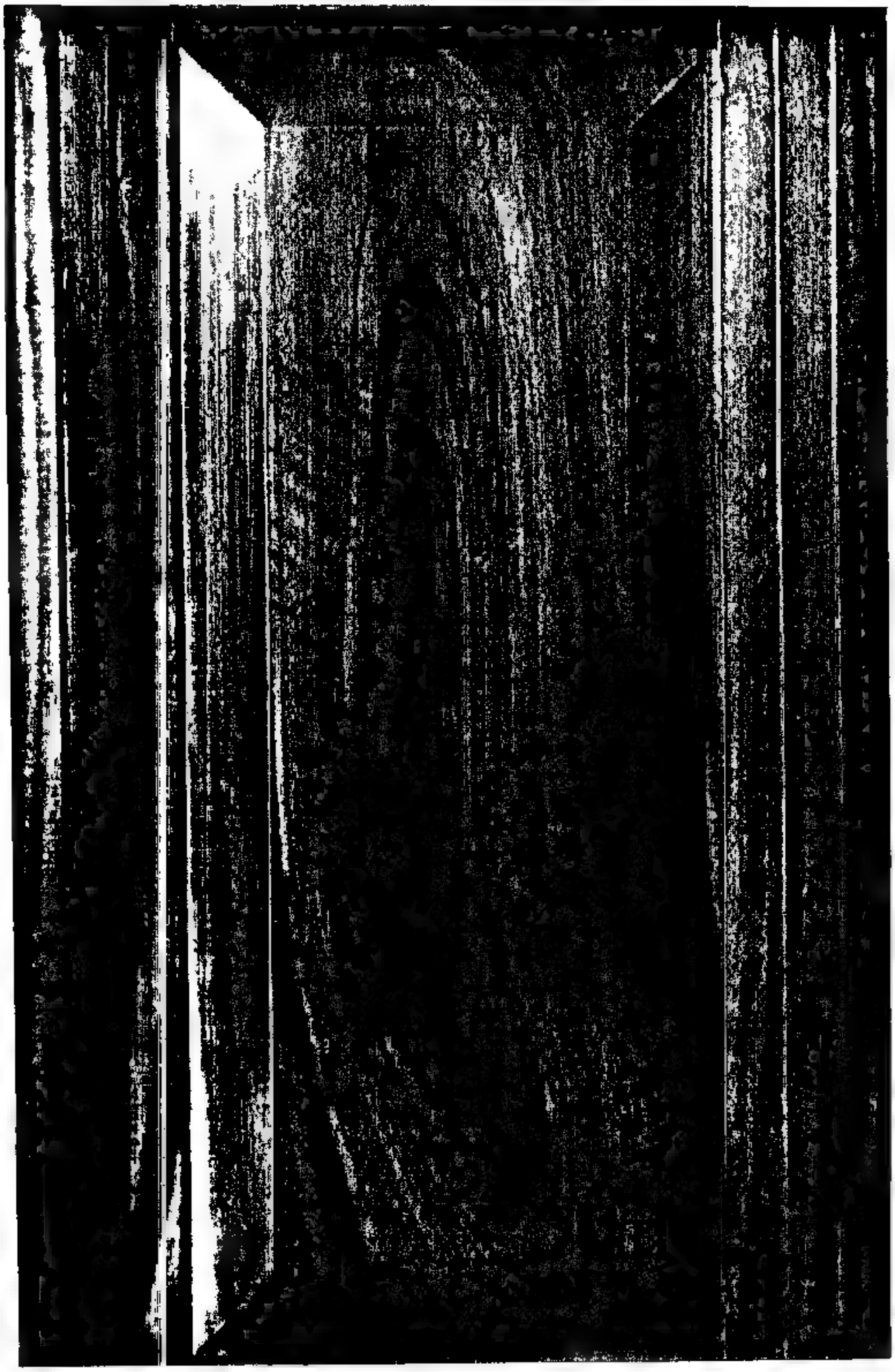
The above are only three instances of the importance of attending carefully to the question of seasoning, but are considered sufficient to illustrate the great importance of this question. It will be noticed that no mention is made in the above record of experiments carried out in artificial seasoning plants, which methods, be it noted, are more applicable to seasoning timbers for special purposes though also in certain cases for constructional timbers.

As another illustration of more intense utilization of our hardwood timbers, some results may be mentioned which can be

obtained by careful cutting and quartering. Many Indian timbers are of an extreme ornamental character, and as such find a ready market: for instance, Blackwood (*Dalbergia latifolia*), Andaman Padauk (*Pterocarpus dalbergioides*), Walnut (*Juglans regia*), Marble wood, *Diospyros oocarpa* and others. Then, again, there are many extremely beautiful timbers which are little known, probably because their ornamental characteristics are not so self evident unless the timber is properly handled. Thus *Tamarix articulata* which, in default of better timber in arid areas, is used for ploughs, Persian wheels and chiefly for fuel, if properly cut yields an extremely ornamental wood; *Populus euphratica*, which has no very high reputation as a timber, but like *Tamarix articulata* owes its importance to growing in arid localities, also when properly cut and seasoned yields a remarkably ornamental timber (Plate 13). Many other instances, such as *Cordia Macleodii*, *Soymida febrifuga*, *Quercus serrata*, etc., which are little known on the market, come under the same category. Then again, such poor class timbers as *Terminalia belerica* and *Sterculia villosa* have been proved to veneer well and make up into excellent three ply boards.

The above instances will probably be sufficient to illustrate what can be done when careful and correct methods are adopted for seasoning, stacking and converting those timbers for which we have either to extend or create new markets. To carry out all these operations require much individual attention, staff and money, besides the necessary plant in which to convert the material, and also for the officer in charge to be in close touch with the market. It is thought that the best way of carrying out this work will be to establish Department Depôts in each province attached to a saw-mill, and to place them in charge of a whole-time man who will work under the orders of the Forest Utilization Officer. Not only would such an officer have every opportunity of studying and developing markets for timbers other than those now readily saleable, but such a depôt could carry moderate-sized stocks of timbers against demand for special purposes.

Panel of *Populus euphratica.*



SOME EXPERIMENTS CARRIED OUT WITH TREATED AND UNTREATED TIMBERS.

We extract the following information from a letter, dated the 30th December 1918, from the Deputy Conservator of Forests, Andamans, Port Blair, to the Forest Economist, Research Institute, Dehra Dun.

Nine pieces of Baltic Pine have been under observation since they were placed in position under the jetty between the log depôt and the swimming bath between high and low tide on 1st September 1916.

The three untreated pieces of Baltic Pine were rapidly attacked by teredo and for the last nine months have been falling to pieces at the base, the upper portions only still being in fairly good condition.

The six pieces of Baltic Pine treated under the Ruping Process (three pieces) and Dry Cell Process (three pieces) have apparently not been attacked at all and are still in good condition.

The two creosoted Gurjan (*Dipterocarpus turbinatus*) sleepers received from you, *vide* your No. 8871 45, dated the 30th June 1915, together with two untreated Gurjan sleepers were also put in position in the sea with the above Baltic Pine on 1st September 1916 The creosoted sleepers are still apparently intact, while the untreated Gurjan are completely eaten through at the base although not falling to pieces as in the case of the untreated Baltic Pine.

In addition to the above, I am making further experiments with Gurjan sleepers and other timber:—

two Gurjan sleepers were painted with *Avenarius carbolineum*,
two Gurjan sleepers with Solignum, and
two Gurjan sleepers with Jodelite

One of each of the above was tarred in addition to being painted as a protection to the treating solution. These six sleepers together with an untreated Gurjan and one Gurjan sleeper tarred only, all properly labelled, were placed in position in the sea with the other timber on 8th November 1917.

The treated Gurjan sleepers are all apparently intact, while the untreated Gurjan has been riddled by teredo at the base. Similarly, I have painted three ladders made of roughly seasoned Pyinma timber :—

one with *Avenarius carbolineum* and tarred,
one with Solignum and tarred,
one with Jodelite and tarred.

Also one ladder made of roughly seasoned white Chuglam (*Terminalia bialata*) painted with Solignum and tarred. All the above have been labelled and are in use in the swimming bath, having been put in position on 17th July 1918.

OFFICE REFORM.

BY J. N. OLIPHANT, I.F.S.

Mr. Gibson's article, in the *Indian Forester* of June 1918, on the lack of up-to-date business office methods in the Department draws attention to a matter in which reform is sorely needed. At the present rate of expansion of forest activities reform will be forced on us before long, and it would be interesting if he would give us in greater detail his ideas as to the lines on which it should proceed. No immediate action seems possible owing to shortage of staff; but when normal conditions are restored, there is no reason why officers should not be placed on special duty to study the question and propose remedies. Should it be decided to take such action, it is to be hoped that the mistake will be avoided of deputing for the purpose men who like office work for its own sake; otherwise the remedy will be worse than the disease. On the other hand, wholesale scrapping of present methods is equally certain to do harm; sound motives underlie most established procedure, and the need is for intelligent simplification rather than destruction.

Great progress has been made in the past year or two in obtaining Government recognition of the needs of the Department, and one cannot imagine any intelligent scheme of office reform supported by the higher forest authorities being turned down on the ground of the comparatively trifling expense involved. The

difficulty lies rather in finding men who can be spared to tackle an arduous and not particularly interesting job. No D. F. O. nowadays has much time to devote to improvements in office methods, which, in the first instance, until they have been established as routine, are apt to give more trouble than they eventually save

It is not, I think, a mere question of obtaining modern office equipment. Such equipment is designed primarily for the use of commercial firms, and the systems to which it is accessory will probably need substantial modification to suit our needs. In the first place, the activities of the average business firm are much more specialized than those of the Forest Department: secondarily, there is necessarily in the department a large volume of internal or interdepartmental correspondence which does not admit of classification on the basis of the names of correspondents—the system most extensively used by commercial firms for correspondence with their clients. While name-indexing would be useful for a certain section of forest correspondence, *e.g.*, correspondence with contractors or having reference to individual employees, the greater proportion of it can be classified only according to subjects It is my opinion that satisfactory subject-classification is the key to efficient organization of forest offices.

The system of classification for filing purposes in the circle to which I belong has been changed twice recently, so the question has been more or less forced on my notice; but I can sympathize with the reluctance of divisional officers in more restful localities, not to mention their clerical staffs, to stir up the dust of ages by an unprovoked attack on the system in being. But clouds of dust will have to be raised before any progress is made.

The history of the changes referred to in the preceding paragraph is perhaps worth recounting. The obvious need for reform of the mediæval system of correspondence classification in force prior to 1917-18 gave birth to a structure most carefully and logically worked out but unfortunately so formidable in its complexity as to reduce the clerical staff to a state of gibbering dementia. This was duly introduced in 1917-18. I fancy the majority of the executive after one agonized glance at the

document relegated it to their long-suffering offices for compliance and (its author having meantime been translated to a higher sphere) fell back in the following year with a gasp of relief on a classification borrowed from a neighbouring circle which Noah doubtless found exceedingly useful in keeping the books of the Ark. Such is the path of the reformer! The system superseded did not, to my mind, deserve such a summary fate. Its chief fault lay in an attempt to prescribe too minutely procedure which should have been left to individual initiative; it also omitted necessary heads and included unnecessary ones.

The mistake made in all classifications of which I have had experience is that of prescribing too comprehensive file-headings. The average Indian clerk is not quick at association and cannot visualize the whole range of subjects that a broad heading covers. This is not intended in a disparaging sense—subject-classification is by no means as easy as it sounds, and filing clerks should really receive special training which, in present circumstances, they do not. My point is that clear-cut definitions are essential in a correspondence classification, and forest work is so extraordinarily varied that these cannot be obtained if the number of file headings is restricted within arbitrary limits. Such restriction, the motive for which is doubtless to avoid complexity in actual practice, defeats its own object.

When classification of documents has reached a reasonable stage of efficiency we can begin to think of abolishing correspondence register; at present, it is the only means of tracing misfiled papers, whose name is legion. With it could go the practice of serial numbering of individual letters, and their identification by case number and date, after the system adopted, apparently with success, for the correspondence of the Indian Munitions Board, could be introduced.

To turn to other points of office reform. The Standing Order, some time miscalled a guard-book circular, is an institution which has been much neglected. Anything of this nature which reduces recurring procedure to routine must obviously save clerical labour. The standing order system is often started and

then, owing to change of personnel, allowed to fall into disuse. Something should be done to ensure continuity, and guard-books of standing orders should be maintained both in circle and divisional offices. The individual orders should be arranged in a loose-leaf file according to the subject classification in force. In a complex division it may be worth while, from time to time, to codify and print as a sort of range manual all the standing orders issued.

The memo form of address should be made compulsory for all interdepartmental official English correspondence. It is appalling to contemplate the amount of paper, type and ink wasted in "having the honour to be."

Abbreviations should be used for all routine phrases (*e.g.*, copy forwarded for information = C. I.), and for terms constantly recurring in internal correspondence (*e.g.*, D. F. O.), Many officers have their own pet abbreviations, but these should be standardized and adopted generally.

Routine communications of a frequently recurring nature should be printed, cyclostyled, or multiplicated from type. This is not done to anything like the full extent that it might be. On the other hand, the extended use of stereotyped forms, must, if efficiency is to be maintained, be accompanied by some system of indexing and pigeon-holing which will render the required form immediately accessible to the issuing clerk.

Probably the first act of any business man tackling the problem of forest office reform would be the scrapping of our ponderous accounts system. There seems no particular reason why the bulk of divisional and range accounts work, and incidentally audit, should not be concentrated in a single office for each circle, with the adoption of an imprest system such as that employed by the P. W. D. Considering the large part of the year during which D. F.O.'s have to be absent from their head-quarters, they cannot be expected to keep their head offices up to the mark.

The establishment of telephonic communications, wherever feasible, should effect an immense saving of clerical work. Stenographers are an obvious need for heavy divisional charges, typist for heavy range charges.

Many other details suggest themselves, but this article is already long enough. In view of Mr. Gibson's remarks on the subject of camp clerks I had better confess to indulgence in three at times; the camp office, be it said, conducts practically the whole correspondence of the division—something over 15,000 receipts and issues annually when last I worked it out. But I deny having ever dictated letters in my bath: that institution is reserved for more choral activities.

EMBELIA RIBES—A MEDICINE FOR INFLUENZA.

BY C. KARUNAKARA MENON, FOREST RANGER.

Embelia Ribes.—Tam. Vayivilangam—a climber belonging to the Natural Order "Myrsinaceæ" is widely distributed in the forests of South Kanara. Many have now recognized the medicinal properties of this forest product, hitherto unnoticed. It has proved to be a very effective medicine during the recent influenza epidemic in these parts. In many cases, a cure has been effected by taking decoctions of the root of this climber twice or three times daily.

There has been no failure in the case of any patient who regularly took decoctions of this when he began to feel the symptoms of this dreadful malady. In my case and in that of my family, it proved very effective. I distributed it widely amongst the villagers and my friend Mr. K. R. Guruswamy Iyer, Forest Range Officer, Coondapur, distributed it freely among the people of Coondapur town; and all those who used it acknowledged their indebtedness to us. People who used this as a preventive in villages where this dreadful disease played its havoc, were not attacked.

EXTRACTS.

PENCIL FACTORY AND TANSTUFFS.

[*Extracts from the Administration Report of the Department of Industries, Madras, for the year* 1917-18.]

Pencil Factory at Washermanpat, Madras.—The Pencil factory continued to work steadily during the year, and progress was made in many directions. The search for a suitable Indian wood for pencils was continued, and more than twenty different kinds of wood were tried. Unfortunately most of these woods had to be discarded, and for the last six months of the year the factory used exclusively cedar (*Juniperus procera*) obtained from British East Africa. Perhaps the most promising wood which was discovered was *Salix tetrasperma* from Travancore, but the tree is not very common or accessible and it has yet to be seen whether pencils made from the wood can be placed on the market at a remunerative figure. Arrangements have been made to experiment with the wood on a fairly big scale. *Rhododendron arboreum* and *Callitris rhomboidea*, both from the Nilgiris, seemed at first promising, but the former is unsuitable since it grows at high altitudes and the tree is usually small, gnarled and crooked.

Very good pencils were made from the latter, but when a bulk sample of the wood was obtained, the wastage on account of knots was so great that the pencils proved to be impossibly expensive. Pencils made from mahogany from Nilambur sold very well in spite of the porousness of the wood, but unless the Forest Department is prepared to provide the wood at very low rates, the pencils are not worth making. There is a steady demand for cheap white wood pencils, and I sold over 3,000 gross at an average rate of Re. 1-5-0 a gross or seven for an anna. But it is difficult to make a profit at this low rate, and my conclusion is that the factory should rely mainly on cedar from British East Africa. German, Austrian and English pencil makers rely mainly on imported cedar, and there is no reason why the Madras pencil maker should not do likewise. Collections of pencils made from the very numerous Indian woods experimented on were presented to the Forest Research Institute at Dehra Dun and to the Gass Museum at Coimbatore. A few more samples of graphite from the Northern Circars were tested, but it seems certain that the factory will always continue to get its graphite from Ceylon. Numerous recipes for colour lacquers were evolved, and a considerable improvement was effected in lead making. Last year only two sorts of leads were made, one for cedar pencils and the other for white wood pencils, but different leads are now made for drawing pencils, shorthand writers' pencils, and carpenters' pencils, while ordinary pencils with hard, medium and soft lead are also produced. Much work, however, still has to be done in this direction, and in time standard grades of pencils with leads of different degrees of hardness will doubtless be evolved. Perhaps the greatest success attained during the year was with copying lead pencils. Fancy prices were paid for methyl violet (Rs. 35 and Rs. 40 per pound), but even so the cost of the pencils was relatively small and they were eagerly bought up at very remunerative prices. In fact from the purely business point of view, I ought to have concentrated entirely on this class of pencil. From the ends of copying pencils after the pencils have passed through the end cutting machine this methyl violet is extracted and used for

making copy stamp ink. This ink is supplied to the Superintendent of Stationery. Blue and red crayon pencils were also made, and the former particularly were quite good. But it was not practicable with the existing machinery to turn them out in large quantities. In a larger factory where separate roller mills and lead presses could be set apart for pencils of this class it would pay handsomely to make them. Experiments have been begun with the manufacture of carbon brushes, and one of the Electrical Engineering firms has already placed an order with the factory for 360 dozen. Attempts were made to make crucibles for baking leads but they were not successful, and as experiments are now being carried on at the Bombay mint, the matter was not pursued.

Financial results.—The factory produced 12,626 gross of pencils in the year, and 12,222 gross were sold, the value of pencils sold being Rs. 33,498-6-4 A number of agents were appointed in July 1917, and the arrangements for the sale of the pencils were completed by the end of August. The following profit and loss account prepared by Messrs. Fraser and Ross, Chartered Accountants, who audited the accounts of the factory, exhibits the financial results of the industry in the seven months ending 31st March 1918:—

Profit and loss account for the seven months ending 31st March 1918.

	Rs. a. p.	Rs. a. p.		Rs. a. p.	Rs. a. p.
To Stock—			By Pencil sales ..		24,531 10 6
Pencils ..	7,804 4 2		„ Stock		
Pencils in process ..	669 11 3		Pencils ..	7,534 14 1	
Sundry materials ..	4,994 1 0	13,468 0 5	Pencils in process	556 6 8	
Stores purchases ..	10,759 6 9		Sundry materials	5,551 13 10	13,643 2 7
Wages and salaries	5,071 10 5				
Engine maintenance ...	1,190 8 8	17,021 9 10			
General charges	75 7 9				
Repairs ..	3 9 6	79 1 3			

	Rs. a. p.	Rs. a. p.	Rs. a. p.
Experimental charges ...		424 0 0	
Packing charges ...		301 6 9	
Depreciation—			
On Engine ..	180 0 0		
On Pencil machinery...	361 0 0		
On sundry plant .	76 0 6		
On buildings	386 0 2		
		1,003 0 8	
Profit for the seven months to date		5,871 10 2	
Total ...		38,174 13 1	
Total ..			38,174 13 1

It will be seen that in these seven months the factory made a net profit of Rs. 5,871-10-2. The figure represents a good return on the comparatively small amount invested by Government in the business, but present conditions are of course peculiarly favourable for a pencil factory in India and an even larger return might reasonably have been expected. It should be remembered, however, that the factory was deliberately run on as small a scale as was consistent with demonstration on commercial lines, and a business firm which was prepared to duplicate the machinery, increase the output and push sales as they should be pushed would undoubtedly make very much larger profits at any rate so long as the war lasts. Nor do I see any reason why the enterprise should not be a permanent success provided that the business is properly managed and capital put into it At any rate Government have done enough in the way of demonstration. All the initial difficulties have been overcome, labour has been trained, Indian woods have been explored and useful experience has been accumulated. It is for private enterprise to carry on, and proposals with this end in view have been submitted to Government. Mr. Ramchandra Ayyar, the Sub Engineer in charge of the Factory, deserves great credit for his energy, determination and skill. He is rapidly becoming an expert in all branches of pencil manufacture and has displayed great ingenuity in overcoming difficulties as they arose.

[NOTE.—The Forest Research Institute at Dehra Dun has tested a number of different woods with regard to their suitability for pencil-making and with the exception of *Juniperus macropoda*, no really suitable wood has been found. A pencil factory in Calcutta used this wood up to the commencement of the war and obtained supplies from Quetta side. Later the supplies were stopped for military reasons.

Cupressus torulosa has been used; it is, however, rather too tough and can only be classed as a second grade wood for this purpose.

Abies Webbiana is used in Calcutta in the production of cheap pencils.

The Small Industries Development Pencil Factory in Calcutta was found to be in full working order in December 1917 and was apparently carrying on a lucrative business. The wood they were using was chiefly *Juniperus procera*, which they obtained from British East Africa.—HON. ED.]

Controller of Tanstuffs.—The immense demand of the War Office for tanned hides, and the increase of production resulting from this demand and from the measures taken by the Indian Munitions Board brought into great prominence the question of supplies of tanning barks. Madras owes its prominent position in the Indian tanning industry mainly to the fact that the Presidency is prolific in *Cassia auriculata* known in Madras as *Avaram* and in the rest of India as *Tarwad*. The bark of this shrub is the great tanning material of Southern India. Its merits are that it is very easy to use and quick in its action, it adds weight and plumpness to the hides and produces a leather which is capable, after further treatment by the currier, of being turned to a variety of uses. The price of *avaram* rose very high owing to the demand for the bark, and the question became so pressing that eventually control was taken over supplies and Mr. R. B. Wood, I.C.S., was appointed Controller of Tanstuffs under the Indian Munitions Board.

Avaram supplies.—Obviously *avaram* bark will always remain the most important tanning material of the Madras Presidency, and the future of the tanning industry will always be bound up intimately with the question of cheap and plentiful supplies of the bark. This question has been brought to the notice of Government, and measures have been taken to encourage the growth of the shrub. But the question of substitutes has also come into prominence. It is being dealt with at the factory of the Esociet Company at Maihar which has been acquired by the Indian Munitions Board, but useful work has also been done on

new tanstuffs and mixtures at the Leather Trade School at Washermanpet.

Experiments with Black Wattle bark.—With the object of meeting the increased demand for tanning materials, the Indian Munitions Board imported a consignment of Black Wattle bark from South Africa, but it was considered inadvisable to distribute the bark broadcast to tanners until careful experiments had been made, and these experiments were conducted at the Leather Trade School by Mr. Kurup under the supervision of Captain Guthrie. Two sets of experiments were tried, some with wattle bark alone and others with mixtures of *avaram* and wattle in different proportions. Finally, a circular was issued to all tanners by Captain Guthrie recommending them to eke out supplies of *avaram* by using wattle bark with *avaram* in the proportion of 100 lb. of *avaram* to the first bark, and 70 lb. of *avaram* and 25 lb. wattle to the first and second barks. Wattle bark is now being used in quite a number of tanneries. It can also be used with Konnai (*Cassia Fistula*) bark.

Mr. Pilgrim's Visit.—Mr. Pilgrim, the Tannin Expert to the Government of India, whose head-quarters are at Maihar, was invited by Government to visit the Madras Presidency in order to investigate the resources of the Presidency in tanning materials, and with the permission of the Indian Munitions Board, he spent some weeks in the Presidency in September last. Advantage was taken of his visit to hold a small informal conference at which Mr. Pilgrim, Mr. P. M. Lushington, Conservator of Forests, Southern Circle, Captain Guthrie and myself were present. The tanstuff position was discussed It was agreed that the most important thing to be done was for Government to organize the collection and distribution of *avaram* bark (a duty subsequently entrusted to Mr Wood), but at the same time it was decided that in order to eke out supplies of *avaram*, experiments with mixtures and other tanstuffs should be begun at the Leather Trade School A tour programme was also mapped out for Mr. Pilgrim, and it was agreed that he should investigate chiefly *Anogeissus latifolia*, the wattles and the mangroves of the Presidency. Mangroves

were studied in the Tanjore district and in the backwaters of Travancore. The mangrove swamps of Tanjore are well known, but unfortunately they consist almost entirely of *Avicennia officinalis* which contains very little tannin. In Travancore the mangrove has, in recent years, been displaced very largely by the cocoanut, but one swamp was discovered where *Sonneratias*, *Bruguieras* and *Rhizophoras* were common. All these mangroves are rich in tannin. *Anogeissus latifolia* was studied on the Kodaikanal ghat where a flush of young leaves was on. Bulk samples both of young and large leaves were powdered into sumacs and gave the following analyses :—

	Sample 1 (much red leaf).	Sample 2 (a bright green sumac).
Tannin absorbed by chromed hide powder ...	*33·14*	*24·99*
Soluble non tannin ...	16·11	14·98
Insoluble matter ...	50·75	60·03
Moisture ...	...	...
Total ...	100·00	100·00

A sample purely composed of red (young) leaves gave the following results :—

Tannins absorbed by chromed hide powder ...	49·21
Soluble non-tannin ...	14·02
Insoluble matter ...	36·77
	100·00

It will be seen that the young leaves are very rich in tannin content, and very promising results have also been obtained at the Leather Trade School with twig bark. The tree is abundant in Tinnevelly, Madura, North Arcot, Salem, Anantapur, Bellary and Kurnool, and there should be a great future before this tanstuff not only for use in Southern India but also quite possibly for export. I was particularly anxious for Mr. Pilgrim's opinion on the wattles of the Presidency. All three species of the tree (*Acacia decurrens*, *Acacia dealbata*, *Acacia Melanoxylon*) are common on the Nilgiris and on the Palnis. The leaves contain tannin but the bark, especially of *Acacia decurrens*, the common wattle, is rich in tannin content. The tannin content has been found by Hooper

to be 25 per cent. in the upper stem bark, 33 per cent. in the lower stem bark and only 15 per cent. in the branch bark, but it has still to be decided by experiment whether better leather is produced by the stem bark or the twig bark, and experiments are to be made at Maihar to decide this point. Wattle bark from the Nilgiris and the Palnis should prove a useful supplement to *avaram* which will probably always remain the mainstay of the Madras tanners but the question on which I wanted Dr. Pilgrim's advice was whether there was any chance of starting an export trade in tannin extracts made from wattle bark. The United Kingdom used to import extracts of wattle bark from Australia and trade in these extracts is now springing up between South Africa and the United Kingdom. Mr. Pilgrim examined the wattle forests of the Palnis and found them to consist mainly of *Acacia decurrens*. Information supplied by Mr. P. M. Lushington, Conservator of Forests, Southern Circle, and the District Forest Officer of the Nilgiris, however, indicated that the quantities of bark available both on the Palnis and on the Nilgiris were not likely to exceed 200 tons a month and Mr. Pilgrim considered that extensive plantations would be necessary before an extract factory would become a commercial proposition. The question, however, has already attracted the attention of private enterprise. I had some correspondence on the subject and I understand that an application has been made to Government for land on concession rates for the purpose of forming plantations of wattle.

New Tanstuffs. On Mr. Pilgrim's advice Mr. Rajamanickam Nayudu was deputed to Maihar to study the 'porridge' method of tanning, the object of which is to extract more completely the tannin in the tanstuff used. With the methods now in use in Madras, it may be noted 7 per cent. of tannin remains in the spent bark which is thrown away. A programme of mixture and other experiments was also drawn up with Mr. Pilgrim's help, and these experiments went on continuously at the Leather Trade School throughout the latter part of the year. Captain Guthrie kindly supervised them but the experiments themselves were conducted by Mr. Rajamanickam Nayudu. The first series consisted of thirty

preliminary experiments on sheep skins with new tanstuffs either by themselves or in different mixtures. The new tanstuffs tried were *Anogeissus latifolia* red sumac, *Anogeissus latifolia* green sumac, *Anogeissus latifolia* twig bark, *Carissa spinarum, Xylia dolabriformis, Phyllanthus polyphyllus* and *Zizyphus xylopyra.* Twelve experiments were next tried on hides. They were not completed by the end of the year and were carried on through the vacation. The results belong properly, therefore, to the report for the current year, but it may be mentioned that particularly promising results have been obtained from the twig and trunk bark of *Anogeissus latifolia,* so much so that the Controller of Tanstuffs has already felt justified in arranging for the exploitation of this bark in large quantities by the Forest Department for distribution through the Government depôts to tanners. Printed vernacular instructions how to use the bark have also been issued. The bark of *Acacia decurrens* is also being freely issued to tanners for use with *avaram,* and so far every tanner who has used it has used it successfully. Red and green sumacs made from *Anogeissus* leaves are so strong that they cannot safely be issued at present to Indian tanners, but European tanners are ordering it in large quantities and appear to find it satisfactory. Further large scale experiments are being carried on at the School with Gottihar fruit (*Zizyphus xylopyra*), *Anogeissus latifolia* and *Carissa spinarum.*

MAKING PAPER FROM DEAD LEAVES.

Both in Europe and in America there has been a sharp rise in the cost of paper, and this has been peculiarly critical in France. Even before the war France imported half a million tons of paper pulp yearly from Austria and Germany, or about half of the whole amount used. The cutting off of the supplies from the Central Powers, and the severe deforestation due to the war have made paper pulp so scarce and so expensive that many periodicals have been forced to suspend publication. It is now proposed to make use of fallen leaves to supply this lack of raw material. On March 27th, M. Edmond Perrier of the French Academy of

Sciences presented before that body an account of the successful experiments along this line of Madam Karen Dramson.

The process is very simple, rapid and inexpensive; the leaves are first crushed, which reduces the blade to powder, which is carefully separated from the ribs and veins. It is the latter which form the raw material for paper pulp. They are subjected to a somewhat rapid lixiviation and are then washed and bleached, whereafter the pulp is ready for use. The leaf powder which remains is used in two ways. It has a high food value, since it contains the digestible and nutritious parts of the leaf after the removal of the cellulose. As a food for cattle its nutritious value is almost equal to that of hay, especially when mixed with molasses and compressed into cakes. The leaf powder may also be used as a combustible. For this purpose it may be compressed into briquettes, either with or without being previously mixed with charcoal powder.

Madam Dramson recommends, however, the practice of dry distillation, by means of which she obtained a comparatively pure porous charcoal rich in calories (6,500 to 7,000 cal.), and easy to agglomerate. The process also yielded an excellent tar, having all the qualities of the so-called Norwegian tar, as well as acetone and pyroligneous acid. One thousand kilograms of the leaves yielded 250 kilograms of pure carbon (or 500 kilograms of edible powder), 30 kilograms of tar, one kilogram of pyroligneous acid and 600 grams of acetone. According to a recent estimate by the Director of the School of Grignon, France produces annually between thirty-five and forty million tons of dead leaves. It is calculated that only four million tons would be required to furnish the paper pulp required in an average year. The economic importance of the question is evident from the fact that in 1913 France paid $20,000,000 for the paper pulp imported from the Central Powers.

It is believed that the collection of the leaves can be done by women, children and war cripples. The leaves can be transported to the paper mills in compressed blocks, but it would be better to build factories on the borders of great forests so as to eliminate the cost of transportation. [*Scientific American.*]

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EXPERIMENTS IN THE POLLARDING OF *BUTEA FRONDOSA* FOR LAC CULTIVATION.

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Usual System of Lac Cultivation.—As a general rule the cultivation of lac on *Butea frondosa* is carried out by lopping off only the lac-covered branches, the new brood being propagated either by leaving a few such branches untouched or by tying up bundles of brood-lac: these bundles are frequently left on the tree and not taken down. This system has certain grave disadvantages, namely, (1) it is expensive owing to the time taken in searching for the lac-covered branches, (2) it does not provide the maximum quantity of lac bearing shoots, and therefore does not obtain the full yield from each tree, and (3) if any lac is left on the tree and after the swarming of the lac larvæ—whether in the form of bundles of brood-lac or of lac left on the living twigs—parasitic and predaceous insects are given time to emerge and infect the next lac brood; these insects are responsible for the destruction of large quantities of lac, and may result in the total failure of the crop.

Nature and Object of Experiments.—With the view of ascertaining to what extent those disadvantages can be eliminated by a system of pollarding, experiments in the pollarding of *Butea frondosa* trees for the cultivation of lac were carried out from 1909 to 1918 at Ranipur in the Saharanpur Siwaliks. The number of trees dealt with was 130, varying from 1′ 2″ to 5′ 10″ in girth; some were in the open, others in forest of varying density. A certain number of trees were completely pollarded on rotations of 1, 1½, 2, 2½ and 3 years respectively, and varying quantities of brood lac were tied up, the results being recorded regularly in the case of each tree. The main objects of the experiments were to ascertain (1) the best method of pollarding, (2) the best rotation for pollarding, so far as the yield of lac and the maintenance of the vitality of the trees is concerned, (3) the quantity of brood-lac required to obtain a full crop and the best method of tying it up, (4) the extent to which parasitic and predaceous insects may be exterminated by the prompt removal of all brood-lac as soon as the lac larvæ have swarmed out.

The results obtained were not conclusive on all points; in particular the crops of lac were poor, but this may be attributed largely to the fact that for climatic reasons the locality is not altogether suitable for the cultivation of lac. The experiments, however, indicated clearly the correct pollarding rotation to employ and the best method of carrying out the pollarding. The results may be summarized as follows:—

Method of Pollarding.—The initial pollarding of the trees should be done with a saw, all branches being cut off to a section of about 2″ to 4″ in diameter, no leafy branches being left on the tree. It is not advisable to cut down to a larger diameter than 4″, otherwise thick corky pollard shoots tend to be formed, and these will not produce lac. The branches should not all be cut off flush, but stumps about 6 to 8 inches long should be left where necessary to form a foothold for climbing during subsequent pollarding operations. The subsequent lopping of the pollard shoots at the time of collecting the lac should be done with a sharp bill-hook or light axe, the shoots being cut off flush from the

base. The pollarding should be complete, no shoots being left on the tree. The experiments amply demonstrated the rapidity with which complete pollarding can be effected in comparison with the lopping of isolated lac covered shoots which have to be searched for.

Pollarding Rotation. —So far as the production of lac is concerned it was proved conclusively that the only satisfactory rotation is one of 1 year. At Ranipur the swarming of the lac larvæ takes place twice a year, usually commencing early in July and late in October; the actual dates when swarming *commenced* in these experiments were the 5th to the 13th July and the 17th to the 27th October except in 1913, when it began as early as the 8th October owing to a dry hot September with little or no rain.

The trees are pollarded immediately before swarming takes place in order to provide brood lac for trees previously pollarded: thus brood-lac may be tied up on trees with pollard shoots aged about 3½ months, 1 year 3½ months, 2 years 3½ months and so on, or 8½ months, 1 year 8½ months, 2 years 8½ months and so on, according as the pollarding is done in July or October. The swarming of the larvæ over the pollard shoots was carefully watched, and it was always observed that they came to rest only on the young green portions of the shoots and the petioles and midribs of the leaves, never on those portions of the shoots which had begun to form corky bark. Now in the case of the more vigorous shoots this corky bark begins to form in many cases in less than half a year, while in shoots more than a year old the length of new green growth each year is very much smaller than it is in pollard shoots of the first year: it follows, therefore, that if the shoots are left for more than one year there is a great diminution of lac-bearing surface on each tree, while in addition the total number of trees available for the reception of lac is reduced with each lengthening of the rotation. Hence we may conclude that *a pollarding rotation of one year produces a far higher yield of lac than any longer rotation.* Of the trees on a given area, therefore, half should be lopped in July to yield the half-yearly lac crop and to provide brood lac for the remaining half, which should in their turn be lopped in October for the same purpose. These

dates naturally refer to Ranipur, and may require to be modified in other localities. These loppings will be alluded to hereafter as summer and winter lopping respectively.

Effect of Annual Pollarding on Vigour of Shoots and Trees.—Annual pollarding was carried on for ten consecutive years, including the initial lopping, except that in one year lopping was inadvertently omitted, so that the shoots were on that occasion allowed to grow for two years instead of one year, though this has not vitiated the general results.

The following statements show the average number of shoots produced each year and their average, maximum and minimum lengths in respect of ten trees lopped annually (except for the hiatus noted), of which five were lopped in the winter and five in the summer :—

Summary of measurements of pollard shoots produced in consecutive years under a one-year pollarding rotation (initial pollarding carried out in April).

Year since initial pollarding	WINTER POLLARDING (5 TREES)		SUMMER POLLARDING (5 TREES)	
	Average number of shoots produced per tree	Average minimum and maximum length of shoots for 5 trees	Average number of shoots produced per tree	Average minimum and maximum length of shoots for 5 trees.
1st ...	189	1′ 2″—3′ 9″	146	10″—7′ 10″ *
2nd ..	137	0′ 7″—4′ 5″	Record lost for one tree.	
3rd ...	139	0′ 8″—3′ 7″	210	9″—3′ 7″
4th ...	109	0′ 6″—3′ [illegible]	180	8″—3′ 4″
5th } 6th }	No pollarding done in 5th year; hence measurements in 6th year do not represent those of 1-year-old shoots			
7th .	116	0′ 4″—2′ 2″	62	2′ 10″—5′ [illegible]
8th	114	0′ 11″—3′ [illegible]″	162	0′ 9″—5′ 2″
9th ...	85	0′ 3″—[illegible]′ 8″		...

* The initial pollarding was carried out in April, and the shoots on this occasion had three months extra growth as compared with subsequent pollardings, which would account to some extent for the greater maximum length.

The detailed figures in the case of individual trees show considerable variation from year to year as regards both number and dimensions of shoots. The average results, however, show no great diminution in vitality after several years of pollarding. This combined with the exceptional capacity of the tree for surviving regular lopping and mutilation for many years, as seen in grazing grounds and elsewhere on the plains of India, would indicate that annual pollarding could be carried out without seriously impairing the vitality of the trees for at least as long a time as would be necessary for the regular replacement of casualties by younger trees. Occasional mortality took place among the trees pollarded during the course of these experiments, but this was no greater than that observed among unlopped trees in the neighbourhood; the cause of this mortality has not been ascertained, but it is probably not attributable to the pollarding.

Cultivation of trees and replacement of casualties.—These experiments have shown that trees growing in an open position produce more lac than trees growing close together. Suitable thinnings are, therefore, necessary where the trees are congested. The filling of blanks and the replacement of casualties can best be carried out by weeded patch or line sowings, while new plantations can be conveniently formed by weeded line sowings, the distance between the lines being about 18 to 20 feet. It is not certain at what minimum girth trees should begin to be pollarded in order not to impair the stock of trees; a minimum girth of 2 feet should give ample safety, while even 1½ feet may prove to be a suitable limit. Under natural conditions the growth is slow, and the replacement of casualties might be insufficient unless there is a considerable stock of small trees. Trees artificially raised, regularly weeded in early youth, and subsequently thinned out at intervals to promote rapid development grow considerably faster. Experimental weeded line sowings at Dehra Dun indicate that a girth of 1½ feet will be reached in 9 years and a girth of 2 feet in 12 years if irrigation is carried out, while a girth of 1½ feet will be reached in 11 years and a girth of 2 feet in 15 years without irrigation.

Extermination of Parasitic and Predaceous insects.—Imms and Chatterjee* have published an account of the parasites, hyper-parasites and predaceous insects affecting lac, which are the frequent cause of immense damage to the lac crop. Some years ago, observing that large numbers of these predaceous insects were only in the larval and pupal stages at the time of the swarming of the lac larvæ, I hoped that by leaving no lac on the trees and removing all bundles of *phunki* lac as soon as swarming was completed, and before the predaceous insects emerged in the perfect state, it might be possible to exterminate or, at all events, largely reduce the pests locally. This theory was tested for four years in the Ranipur experiments, but no marked diminution in the pests was observable. It is true that by the prompt removal of all *phunki* lac large quantities of parasites were destroyed, but each succeeding brood was found to be as badly parasitized as the previous one, no fewer than nine different species having been collected during the course of these experiments. This failure can probably be attributed, in part at least, to the fact that indiscriminate lac cultivation is practised in a neighbouring locality, and each lac brood was probably parasitized afresh from outside. The results of breeding experiments recorded by Imms and Chatterjee† show that in the case of some of the worst pests a large proportion of the emergence takes place after the swarming of the lac larvæ, and although it may not be possible to exterminate the pests completely in a given locality, the prompt removal of all lac, as soon as swarming takes place, must result in an eventual diminution of the pests *provided no indiscriminate lac cultivation is carried out in any neighbouring locality*. The value of complete pollarding in this respect will thus be realized. Not only should all *phunki* lac be removed, but all topped shoots and twigs should be collected and burnt as soon as the lac has been stripped from them, since fragments of lac

* A. D. Imms and N. C Chatterjee, On the Structure and Biology of *Tachardia lacca*, Kerr, with observations on certain Insects predaceous or parasitic upon it.—*Ind. For. Mem For. Zoology Series, Vol III, Part I.*

† *Loc cit* pp., 29—38

frequently remain on them ; also when the leaves fall from about January to March they should be collected and burnt, since the petioles and midribs are frequently coated with half formed lac.

The following statement, giving the dates of the swarming of the lac larvæ and the emergence of predaceous or other insects subsequent to the swarming, will indicate the necessity for the prompt removal of *phunki* lac from the trees :—

Dates of commencement and end of swarming of lac larvæ and first and last recorded emergence of predaceous or other insects from phunki *lac, Ranipur.*
(Observations made by the Forest Zoologist).

Name of predaceous or other insect.	1910. 2nd lac generation: Lac	1910. 2nd lac generation: Pests.	1911. 1st lac generation, 2nd lac generation.: Lac.	1911: Pests.	1911: Lac.	1912. Lac only: 1st generation	1912. Lac only: 2nd generation	1913. Lac only: 1st generation	1913. Lac only: 2nd generation
1 *Eublemma amabilis*, Moore	25th Oct.—7th Nov.	7th Nov 1910—23rd May 1911.	12th July—22nd July or later	21st July—26th Oct	17th Oct.—after 2nd Nov.	9th—26th July	27th Oct.—15th Nov. (A few continued swarming till 29th Nov. on warm afternoons.)	5th—26th July	8th—31st Oct. (Early swarming due to dry hot weather in September.)
2 *Holocera pulverea*, Meyr		7th Nov.—11th Nov. 1910.		15th July—6th Oct					
3 A [illegible] moth		17th Nov							
4 *Stanarethora spadoshtha*, Meyr		1?th Nov		.					
5 *Sierannatsis iyeri* Grouv		10th Nov		...					
6 *Bergmas maindroni*, Grou.		10th Nov		21st—22nd August.					
7 *Lissenytrus tronpe* Cam.		11th Nov.		14th July—1st Sept					
8 *Chrysopa* sp.		24th Nov. 2 specimens only							
		None emerged after 31st May 1911.							

Tying up and Removal of Brood-lac.—Complete pollarding of the lac-covered trees is carried out a few days before swarming is expected, and the brood-lac for the trees pollarded at the collection of the previous crop, and now ready for the reception of a new generation, is obtained by cutting the lac-covered lopped shoots into lengths of about 6 to 10 inches. Experiments were made in tying up varying quantities of brood-lac, and it was found that a much greater quantity was necessary than under ordinary partial lopping, owing to the large lac-bearing surface. The aim should be to cover all the pollard shoots with larvæ, and for this purpose the quantity of brood-lac tied up can hardly be too great. Different methods of tying up the lac were tried, but the most successful was that advocated by Mr. Misra,* namely, to place sticks of brood-lac in loosely constructed baskets and tie the baskets up in the branches. In the present experiments about 40 to 50 sticks of lac were placed in each basket, and varying numbers of baskets up to 14 were hung in each tree. Generally speaking, it was found advisable to fix up one basket at the base of each small clump of pollard shoots either by pushing the basket into the clump or by hanging it up by means of a wire hook. The baskets should, as already pointed out, be removed as soon as swarming is over, and for this purpose a few marked shoots, low down on a tree, should be impregnated and watched from day to day during the time of swarming, in order to ascertain when swarming is nearly at an end; the same shoots should again be watched some little time before the next swarming begins in order to note the first signs of swarming.

Radius of activity of Lac Larvæ.—The longest one-year-old pollard shoot is of such a length that the lac larvæ can easily travel from its base to its tip before coming to rest, and hence there is no need to fix up the baskets of lac otherwise than in convenient places at the bases of clumps of pollard shoots. Larvæ, which swarmed from sticks of lac laid on a concrete floor on the 4th July 1912, travelled up an adjacent whitewashed wall and pillar

* C. S. Misra, The Cultivation of Lac in the Plains of India, *Agri. Res. Bull. No.* 28, 1912.

and came to rest in large numbers along a projecting cornice several feet up: the distance of the furthest mass of larvæ from the nearest stick of lac was 9 feet: this shows that even in such unnatural conditions the larvæ can travel in large numbers to a distance of several feet before coming to rest.

Treatment of Lac after removal from trees. From the moment the lac is removed from the trees precautions should be taken to prevent the parasitic and predaceous insects from escaping. For this purpose the lac should be tied up securely in bags for removal, while for subsequent drying the use of gauze cages or rooms is suggested as a means of preventing the escape of the pests.

Lefroy has recommended fumigation with $C\,S_2$.* I tried placing sticks of lac for a short time in boiling water, but this proved unsuitable, as the lac became partly hydrolysed and was rendered useless for the manufacture of shellac.

Miscellaneous Observations.—The following observations, some of which confirm what is already known, were made during the course of these experiments.—

(1) *Conditions affecting Swarming.*—Swarming is most vigorous in warm bright weather and during the warm hours of the day: it ceases partially or entirely in cold rainy weather and in the cool hours of the morning and evening. Heavy rain and high winds at the time of swarming, until the larvæ are firmly attached to the trees, are very harmful.

(2) *Flowering and Fruiting of Pollard Shoots.*—A few flowers were produced on shoots 16 months old, on trees lopped in October: only one tree in nine produced flowers. On pollard shoots 22 months old, on trees lopped in April, flowering and fruiting was general and plentiful.

Illustrations.—Plate 14 shows a tree recently pollarded, Plate 15, Fig. 1, the same tree at the time the brood-lac is fixed up, and Plate 15, Fig. 2, the same tree with lac-covered shoots one year old ready for pollarding again.

* H. Maxwell-Lefroy, Lac Fumigation *Agr. Journal India*, Vol III, pp. 176-7.

Photo.-Mech. Dept., Thomason College, Roorkee.

Butea frondosa tree lopped in preparation for lac cultivation: photograph taken in the end of November, about 6 weeks after lopping, showing numbers of young shoots beginning to sprout.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 1.—Same tree the following July, at time of impregnation with brood-lac.

Fig. 2.—Same tree the following October; lac-covered pollard shoots, one year old, ready for lopping.

Conclusions and Inferences. These experiments lead to the following main conclusions and inferences regarding the cultivation of lac on *Butea frondosa* :—

(1) So far as the yield of lac is concerned the best results are obtained by complete pollarding on a rotation of one year, half the available trees being lopped for the summer crop and the other half for the winter crop.

(2) The vitality of the trees is not seriously affected by annual pollarding for a series of years, and may be presumed to last long enough to allow for the regular replacement of casualties by young trees.

(3) The most suitable minimum size of trees for pollarding has not yet been ascertained, but a minimum girth of 2 ft., and perhaps of 1½ ft., should give an ample margin of safety.

(4) Isolated trees produce more lac than those grown close together, and hence trees, whether of natural or artificial origin, should be thinned out periodically from an early age where they are congested.

(5) Brood lac placed in loosely made baskets should be fixed up in large quantities at the bases of clumps of pollard shoots, in order to cover with larvæ the extensive lac-bearing surface afforded by the annual pollard shoots.

(6) The prompt removal of all lac collected from the trees and of all brood-lac as soon as swarming is over, as well as the burning of all remnants of loppings and of all fallen leaves, tends to destroy numerous parasitic and predaceous insects which emerge after the swarming of the lac larvæ ; no marked diminution of the pests, however, may be expected if indiscriminate lac cultivation is practised in the neighbourhood.

(7) Steps taken to prevent the escape of the pests from the lac collected, by removing the latter in closed bags, and the destruction of the pests by fumigation, should tend towards their diminution.

THE FUTURE ORGANIZATION OF THE FOREST DEPARTMENT IN INDIA.

BY "ARPI."

The impetus given to the important problem of the full development of the enormous forest resources of the Indian Empire by the Great War must lead to much searching of the heart as to the best means of providing for the control and execution of work entrusted to the Indian Forest Department. A thorough ventilation of the views of every school of thought and even of individual opinions on this important question cannot fail to be of benefit, therefore, at the present time. Anything that is set down in this article is but the personal opinion of the writer, expressed somewhat dogmatically of set purpose in order to provoke criticism, which will doubtless be most *destructive* but also it is hoped *constructive*.

2. For the reason that the writer is sufficiently radical in his views to desire a complete "*bouleversement*" of the old order and the setting up a brand new order, the present organization—would it be so very far wrong to use the word "disorganization"—is not reviewed in this article. But enough of "padding"! To come to the root of the matter, permit the writer to state boldly the scheme which he, ignorantly perhaps, but none the less earnestly, advocates. The organization proposed is briefly summarized in the following statement :—

I. Forest Police consisting of —

(1) Superintendents and Assistant Superintendents.

(2) Inspectors and Sub-Inspectors.

(3) Constables.

II. Forestry Branch consisting of—

(1) Administrative section (Conservator).

(2) Controlling section (Gazetted trained Forest Officers).

(3) Executive section (Forest Rangers, Deputy Rangers and Foresters).

III. Forest Engineering Branch consisting of—

(1) Administrative section (Chief Engineers).

(2) Controlling section (Deputy and Assistant Forest Engineers).

(3) Executive section (Overseers, Sub-overseers and Foremen).

IV. Forest Exploitation Branch—

(1) Administrative section (Chief Exploitation Officer).

(2) Controlling section (Deputy and Assistant Exploitation Officers).

(3) Executive section (Supervisors, Assistant Supervisors and Foremen).

V. Forest Department Secretariat consisting of—

(1) Government of India (Inspector-General of Forests with Forestry, Engineering and Exploitation Assistants).

(2) Provincial (Chief Conservator with Forestry, Engineering and Exploitation Assistants).

Such is the skeleton scheme which the writer advocates; it remains to explain briefly how the various branches would be manned and how they would work in practice.

Forest Police.—This branch of the Forest Department would be responsible for those police duties, connected with the protection of forests from damage by man, which absorb such a large share of the time of trained forest officers at present. This branch would relieve trained forest officers entirely of such work and would merely be connected with Divisional Forest Officers in so far as (i) returns would be made to the latter, (ii) questions of rights and concessions would be primarily dealt with by the Divisional Forest Officer and (iii) the Superintendent of Forest Police and the Divisional Forest Officer would come under the control of the Deputy Commissioner or Collector.

The staff of this branch would be recruited from the same sources as the ordinary police force and neither gazetted, subordinate nor protective staff would require any training in forestry. The organization would be based on the forest division or civil

district (whichever was larger), each division or district having its Superintendent or Assistant Superintendent according to the importance of the division *from the point of view of protection.* Inspectors would hold direct charge of an area corresponding with Forest Ranges at present, while Sub-Inspectors would act either as assistants to Inspectors or as "patrol" officers. Forest police constables would some be placed in territorial charges (beats) and others be posted to a gang patrol, of which the duties would be to patrol the forests of one Range with a view to supplementing the work of the beat constable, who often cannot, and generally does not want to protect his beat efficiently, although he is necessary as knowing the locality and the local habitual offenders and indeed most of the inhabitants of villages in his beat. The conditions of service of this Forest Police Branch should be the same as for the ordinary police force.

Forestry Branch.—This would consist of the members of the existing Forest Service between the rank of conservator and the rank of Forester. Their duties would almost entirely lie in the sylvicultural field, including plantations, regeneration, thinnings, improvement fellings and main fellings, but they might also be responsible for ordinary forest inspection paths and simple buildings such as Forest Guards' huts and all temporary paths and buildings. They would also naturally concern themselves with sylvicultural research, preparation and control of working-plans, industrial investigations and all forest operations not involving the exploitation of timber, such as fuel works, resin-tapping and similar works. With the backward state in which the greater part of the Indian forest estate is at present and with the opening for far more intense systems of management which admittedly exists, coupled with the good prospects before new developments of forest resources, it is permissible to claim that this branch would have its hands full even with the restricted duties inherent in the scheme as compared with existing conditions.

The conditions of service should therefore remain at least as good as they are at present, though it is to be hoped that the anxiously awaited improvements in these conditions will not be

long in materialising, as they have done already in the case of the Indian Police.

Forest Engineering Branch.—The question of the appointment of Engineers, well versed in all engineering problems connected with the conversion of timber and the extraction of timber and other produce, has received and is receiving attention. The case for the employment of such engineers requires no argument in this place. It will probably be best to keep such a service on a provincial, as opposed to a divisional basis. The branch will, of course, be intimately associated with the Forestry and Exploitation Branches—with the former chiefly in connection with working-plans and with the latter at almost all times. As such engineers and their subordinate staffs will be quite as much technical experts in their own line as trained forest officers and their subordinate staffs, it is certain that the conditions of service must be on practically the same basis as for the Forestry Branch.

Forest Exploitation Branch.—At any rate in the more accessible forest regions, in which intensive systems of management exist or are about to be introduced, there can be little doubt that *the system of departmental exploitation is to be preferred to the* system of sales of standing trees. This is not the place to argue this subject, which is worthy of a special article, and it need merely be emphasized that departmental working is somewhat rapidly coming into its own again over large areas of the Indian Empire. This being so it is more than open to question whether the existing forest staff can, in view of the rapid progress towards intensive management, coupled with the development of forest resources satisfactorily control exploitation in addition to their heavy sylvicultural duties. Nor is it probably advisable to meet the problem by a heavy increase in the staff of officers highly trained in sylviculture, since exploitation work can be as well, if not better, done by a class of officer who has had long and practical experience of the exploitation of timber with its difficult labour problems and its call for a sound practical knowledge of the requirements of the timber trade. It is believed, therefore, that the best

results will follow from the recruitment of a special Exploitation staff, whose sole duty would be to fell and convert trees marked by the Forestry Branch, to carry timber to the market and dispose of timber brought to depôts. No knowledge of sylviculture is necessary for such work, though a working acquaintance with engineering would be desirable. Considering, however, the responsible nature of the work which this branch would have to control and manage it is most necessary that both gazetted Exploitation Officer and subordinate staff should be well paid. Perhaps the pay of corresponding classes should not be so high as that of highly trained technical forest officers, while another reason for keeping the pay of gazetted officers of this branch lower than in the Forestry Branch, at any rate in the case of Deputy and Assistant Exploitation Officers, would be that in many respects they would necessarily be under the orders of both Divisional Officers and Forest Engineers. In the case of subordinate staff, however, it would probably be advisable to pay the Exploitation staff as highly as Forest Rangers, Deputy Rangers and Foresters, as the case might be, in view of the fact that subordinates of reasonable honesty are essential in work involving the handling of very valuable property. It is suggested, therefore, that gazetted officers of the Exploitation Branch should draw 1/5th less pay than gazetted officers of the Forestry and Engineering Branches, but that the subordinate staff should be on the same footing in all three branches as regards conditions of service.

The object of what has, for want of a better name, been called the "Forest Department Secretariat" is to give a body of superior officers, with the requisite expert assistance, who can direct and control the general policy of the Forest Department as a whole, and act as the technical advisers of the Government of India or Provincial Governments as the case may be This supreme control is, under these proposals, vested in members of the Forestry Branch, which is after all the senior branch of the Department and upon which ultimately depends the whole work of the Department in all its branches. It is also for consideration whether the Inspector-General of Forests should not be a Secretary

to the Government of India for Forests, continuing to work under the Member for Revenue and Agriculture: while Chief Conservators would be Secretaries to the Provincial Governments. The assistants of the Inspector-General of Forests and Chief Conservators for Forestry, Forest Engineering and Exploitation should probably be the most experienced and best *(not necessarily the most senior)* officers of each branch: their status should, it is thought, be that of Assistant Secretaries to the Forest Branch of the Imperial or Provincial Secretariat, since the growing importance of the work of the Forest Department in the Indian Empire would appear to justify a stronger representation of the Department at the head-quarters of the Imperial and Provincial Governments.

No attempt has been made in this article to go into great detail or to explain with any precision the duties of each branch of the service or the exact manner in which the work of different branches will react upon each other and will be co-ordinated. All that has been attempted is to set down briefly a scheme, which quite possibly may prove inacceptable to most of the department, but which, in the writer's opinion, is capable of producing greater efficiency with the minimum waste of power

GEOLOGY AND FOREST DISTRIBUTION.

BY E. A. SMYTHIES I F S, SYLVICULTURIST, U. P.

There is one aspect of Forestry in India which has scarcely received the notice it deserves, and that is the effect of Geology and rock formations on the distribution and quality of Forest types. In parts of India, such as the Gangetic plain, and the Deccan trap areas, there are vast stretches of country where the rock formation is homogeneous, and the varying effects of geology are, for that reason, not in evidence. But in other areas, *e.g*, the Himalayas, and the sub-montane districts, where different rock formations crop out with greater frequency, it is instructive to see how the geology is often a dominant factor in the distribution of forest types.

Let me illustrate my meaning by an example. The Naini Tal district in the U. P. contains portions of three forest divisions. The geology is extremely varied, and the forest types are correspondingly varied. The geological types of rock are as follows:—

Epoch.	Rock formation.	Sub-divisions and rock types.
Recent ...	Recent alluvium ..	(1) Sands and gravels of river valleys, cones of detritus deposited by rivers. (2) Gravel deposits of the Bhabar. (3) Alluvium of the Terai.
Tertiary ...	Siwalik formation ..	(1) Upper Siwalik conglomerates. Coarse river gravels, pebbles and boulders of the high level beaches, often ridged up by earth movements into low hills and elevated plateaux, up to 2,700'. (2) Middle Siwalik sand rock. A soft sandy friable rock, easily denuded, dry and porous, up to 2,300'. (3) Lower Siwalik Nahan Sandstone. A fertile indurated rock, much affected by earth movements, and found up to 6,000' elevation.
Precambrian ...	Krol series ..	(1) Blue limestones, (2) Purple slates, (3) Quartzites, (4) Trap rock: All very indurated and affected by earth movements, and much folded and faulted. Unfossiliferous. 3,000' up to 8,600'.
Archean ...	—	(1) Mica schist, (2) Gneiss: 4,000' up to 8,000'.

In these older rocks, there are huge differences of altitude so that the effects of differences of height to a great extent mask the effects of differences of rock types. Not altogether however; for example, the Trap rock is everywhere characterized by a wretched scrubby growth of miscellaneous species, such as Bauhinias, *Sapium insigne*, Euphorbias, etc. In one place in the

Naini Tal district, a tiny stream forms the boundary between Siwalik rocks on one side and Trap rock on the other; one side of this little stream is clothed with the most magnificent chir pine forest, the other with worthless scrub, in which not a single chir seedling, sapling, or tree is to be found!

Similar examples of abrupt alterations in forest growth due to alterations in the rock formations are probably within the experience of most Foresters in India. Again, the blue limestones are characterized by a practically complete absence of chir pine forests but produce the finest growth of high-level oak forests on cool slopes. A peculiar type of oak forest (*Quercus lanuginosa*) is confined exclusively to the quartzites, which also hold all the finest pure chir pine areas; twisted fibre pine forests are confined in this district exclusively to the archean mica schists and gneisses, and do not occur on the quartzites and slates. The great boundary fault between the Tertiary and Precambrian rocks runs without a break from one end of the district to the other, and is everywhere coincident with the abrupt termination of the Sal forests, which are confined to the Siwalik formations to the south and a decent Sal tree is nowhere found on the older rocks. But it is when we get to the Tertiary and Recent deposits, where the differences in altitude are not so marked, that we can trace in greater detail the effects of geology on the distribution of the different forest types. In the Ramnagar Division especially, it is remarkable with what extraordinary fidelity the forest types follow the geological formations. There are three types of Sal forest, which are sufficiently distinctive to be made into three different working circles, *i.e.*: (1) Sal forests under a regular method These are confined exclusively to the Upper Siwalik conglomerates; (2) Sal forests of the Protection and Improvement Working Circle. These monopolize the middle Siwalik sand rock; (3) Sal forests of the Selection Working Circle All Nahan sandstone areas fall into this Working Circle.

But working circles of necessity are rounded off on broad lines, and often include odd patches of forest types alien to the general type, and it is when we come to study the forest in great detail

that the striking influence of geology on the forest type is apparent. is scarcely an exaggeration to say that a detailed stock map, coloured in to show the different *types of forest* would serve equally well as a detailed geological map, or *vice versâ!*

It is impossible to regard such a phenomenon as a series of remarkable coincidences, and the conclusion is inevitable in such cases that the geology of a tract is a *predominant factor in the distribution of forest types.*

The same fact is to be observed in the variations of the Recent deposits but need not be detailed further, as I have, I hope, given sufficient examples to prove the point.

It may, however, be asked of what practical use it is to know that geology has a marked effect on forest distribution. It is not many years ago that an Inspector-General of Forests considered the study of geology for Forest Officers a waste of time, and I believe I am correct in saying that it has more than once been mooted to drop the study of geology, of soils and rock formations, from the syllabus at Dehra. But surely it *is* important to study all factors that affect forest growth and distribution, more especially so in connection with the preparation of Working Plans, or plantation schemes. Let me give two illustrations :—

(1) *Holoptelia integrifolia* is a forest tree, whose timber has been shown to be excellent for several purposes, and a big demand for this species will probably arise. Its present distribution is, however, very limited, and a suggestion has been made to utilize some of the waste lands for plantations. A study of the geology of the areas where *Holoptelia* occurs naturally shows that it is confined exclusively to recent alluvial deposits, and more especially is found on recent river gravels, and only occasionally on sandy or loamy deposits. In starting *Holoptelia* plantations, therefore, we should naturally select areas with similar soil conditions (*i.e.*, on recent river gravels), and eliminate at a step extensive areas where our labours would probably be in vain, and where anyhow some other species would give greater hope of success.

(2) Again it has been proposed to improve some of the open and rather worthless forests of the Siwalik formations by the

introduction and encouragement of the chir pine, which is often found occurring naturally at surprisingly low elevations. In the Ramnagar Division there are magnificent natural chir groups to be found at 1,400 ft. But the point is this, that it is only found at these low elevations on or in the immediate vicinity of the upper conglomerate formation, where it is spreading and developing naturally, and requires no artificial assistance. On the Nahan sand-stone and sand rock stages, chir is seldom found below 3,500 ft., and the possibility of its *successful* introduction in areas where it fails to come up naturally is at least very doubtful. These two illustrations will suffice to indicate the importance of a study of the geology of an area before deciding on the proposals for future management, and future experiment.

It is customary in Working Plans to give a description of the geology of the tract dealt with; in very many Working Plans all reference to the geology stops with the description, and no attempt is made to show the effect of the different rock types on the forest growth, although this is so evidently the reason why the Code prescribes that a description of the Geology should be included in Part I of the Working Plan.

This note is a plea for the closer study of geology and rock formations in connection with Forestry in India, and although I personally know only a comparatively tiny area, I cannot believe that the principle is of only local application. The subject is such an interesting study in itself that I believe it only requires a little publicity to be very widely adopted.

SPRUCE RED WOOD.

BY H. M. GLOVER, I.F.S.

The Himalayan Spruce throughout the Punjab hills tends to produce a red, so-called "heart-wood," which apparently varies considerably in different localities and in different individuals. Sometimes scarcely any is present and the red wood in individual trees is either entirely absent or extends for only ten feet or so up the stem but often trees of all girths contain for three-quarters of their length a red centre, which turns dark brown on exposure

to the air. It does not follow the annual rings but forms a splodge with projections extending irregularly across them resembling nothing more than the well-known advertisement of Stephens Blue Black Ink. The red centre is invariably much moister than the sapwood, liquid oozing out of the tree when freshly cut, sometimes in considerable quantities. This liquid stains sapwood on which it may fall a light red colour turning to brown after a short time. Extending downwards from large branches a band of red wood is often found while, generally speaking, a tree with many branches is more likely to contain red wood than a tree grown in dense cover

This question is of the greatest possible importance in view of the present extensive schemes for working the Punjab Spruce forests for railway sleepers. The red wood is of high specific gravity (about 60 lbs. to the cubic foot) and *will not float* for the length of time necessary to land it at the sale depôts.

Transport is dependent entirely on water and up-to-date experiments in floating red wood Spruce have yielded negative results. In fact the red wood appears to be water-logged when it first comes out of the tree and traders leave it to rot in the forests, filling them with rubbish and reducing their yield for export. Drying experiments under natural conditions have been carried out with the result that the red wood loses half its weight within six months and becomes nearly equal in weight to white wood, which floats easily.

This note does not pretend to be complete—if it were, one of the most important problems in connection with exploitation in the Himalayas would have been solved. Spruce is now for the first time being worked on a large scale for creosoted railway sleepers and was recently experimented with for Aeroplane construction, so the existence of red wood, which has been known to the trading community and to some, though not all, forest officers for years, is now assuming increased importance. The wastage caused by this red wood being left lying in the forests has amounted to as much as 50 per cent. of the estimated outturn. Now that Government is working the forests departmentally, a

considerable quantity of sleepers will be cut from red wood and will be thoroughly dried and sent down on flood water. It remains to be seen if dried red Spruce sleepers are more absorptive of water than white Spruce sleepers and if so, whether they will absorb water too rapidly for them to reach the depôts. Meanwhile, the assistance of the Imperial Forest Botanist and Economist as regards testing the structure and mechanical properties of red wood is eagerly awaited. It is understood that this question will engage the attention of the Officers of the Research Institute during the ensuing year. In the meantime it is causing all estimates to expenditure and outturn to be upset and is filling our felling areas with débris, and a practical solution of the floating problem is required urgently.

PRELIMINARY WATER ABSORPTION TESTS.

(Specimens dried under natural conditions and then floated in open tank and weight reduced to one cubic foot basis).

RED WOOD.

	Weight.	Specific gravity.
Cut from trees felled 6 months previously	936 ounces	·936
After drying for 6½ months	492 ,,	·492
Immersed in water after 2 months	744 ,,	·744

Water absorption in two months 252 ounces per cubic foot.

WHITE WOOD.

	Weight.	Specific gravity.
Freshly cut	732 ounces	·732
After drying for 6½ months . ..	384 ,,	·384
Immersed in water after 2 months	636 ,,	·636

Water absorption in 2 months 252 ounces per cubic foot.

POSSIBLE USES FOR ROSIN IN INDIA.

BY A. J. GIBSON, I.F.S.

History appears to be always repeating itself. In the early days of the American "Naval stores" industry producers did not know what to do with their rosin, as there was only a demand for the turpentine. Consequently at the early primitive "stills" set up in the forests to manufacture turpentine, the rosin was dumped in adjacent streams or in holes dug in the ground. Such deposits later came to be known as rosin "mines," and when rosin became established as an article of value many persons made small fortunes by locating these "mines" and marketing their contents. For the above information the writer is indebted to a pamphlet by the National Turpentine and Rosin Bureau, New Orleans, United States of America.

Matters have changed since then and in a recent issue of a trade journal, dealing mainly with rosin and turpentine, the uses of rosin occupy well over a column of small print. Soap factories, paper concerns and paint and varnish manufacturers, in the order named, consume most of the rosin used in the United States of America.

India now is going through the phase America went through years ago and is faced with a brisk demand for turpentine, a demand considerably in excess of the supply at present, and a lagging demand for rosin, resulting in heavy stocks in hand.

There are several remedies

The simplest is to export the surplus rosin. But as rosin is used in a mass of other industries, the sounder policy is to encourage those industries in India and thus reduce the long list of articles India has to import. Acting on this idea the Jallo Rosin and Turpentine Factory started this cold weather laboratory and commercial scale experiments in the destructive distillation of rosin, as the process yields rosin gas, pinolene or rosin spirit, rosin oils and pitch. These commodities are used, in the order named, for illuminating purposes, cleaning and burning purposes,

lubricants and lubricating greases, caulking and insulating purposes. This is only a brief list, but as the object of this article is mainly suggestive it will have to suffice.

The experiments at Jallo were successful and the processes found to be within the scope of ability offered by Indian labour. The yield and quality of the products was satisfactory and the processes of purification not unduly complicated. The co-operation of the Industrial Laboratory of the Forman Christian College, Lahore, has been secured and so within a few months data will be available to go ahead on a commercial scale. It is, however, not the work of the Forest Department. The department can provide the raw material and, if necessary, demonstrate the practicability of a process in a pioneer factory. The rest must be left to private enterprise.

This note is intended to show the two courses open to India :—

(1) to export its surplus rosin leaving India richer in rupees and poorer in industrial expansion ;

(2) to work up its surplus rosin into products which India requires, and which products have at present to be imported, thus doing something to develop India industrially and leaving it not only richer in rupees but in industrial expansion as well.

Economically, the writer cannot help thinking that the second course is sounder. If so, work on these lines should be developed.

A NEW SPECIES OF *TAMARIX*.

BY R. S. HOLE, I.F.S.

In September 1916, Mr. R. S. Troup, Assistant Inspector-General of Forests, sent the writer specimens of three species of *Tamarix* from Baluchistan for identification. No less than two of these specimens could not be matched with the literature and herbarium material available at Dehra Dun. Subsequent examination of the herbarium material at Sibpur, Calcutta, was also unsuccessful. One of these specimens is in fruit only and it is desirable that flowering specimens should be obtained before it is finally dealt with. The other specimen in the writer's opinion is

conspecific with the tree hitherto known as *Tamarix gallica*, Linn., in the plains of the Punjab, Sind and United Provinces. It is certainly quite distinct from *T. gallica*, Linn., and is most closely related to *T. arabica*, Bunge. The latter species, however, differs strongly in the type of leaf which is remarkably constant in the Indian tree, while the latter, also, has usually much longer racemes. It is true that *T. arabica* is at present very imperfectly known and it is possible that additional material of it may in the future justify the placing of the Arabian and Indian tree in one species, but in view of the existing differences between them and of the confusion which has been caused in the past by the identification of extra-Indian with Indian species it is, in the writer's opinion, at present impossible to combine them I have, therefore, named the Indian plant after Mr. R. S. Troup who obtained the specimens which led to this study and who throughout his service has consistently endeavoured to stimulate the study of Forest Botany in India.

The following is the diagnosis of the species :—

Tamarix Troupii, Hole. (Syn. *T. gallica*, quoad spec. ex Punjab, Sind, United Provinces, Dyer, Fl. Brit. Ind. I, 248, 1874; Brandis, For. Fl. 20, 1874, Ind. Trees 45, 1906; Gamble, Man. 46, 1902; non Linn.)

Species *T. arabicæ*, Bunge, affinis sed differt racemis longioribus foliis brevioribus latioribusque.

Tamarix Troupii, Hole (Syn. *T. gallica*, Dyer, F. B. I., I. 248, 1874; Brandis, For. Fl. 20, 1874, Ind. Trees 45, 1906; Gamble, Man. 46, 1902; in so far as these authors refer to specimens from the Punjab, Sind and United Provinces but not of Linnæus).

Species allied to *T. arabica*, Bunge, but differs in the longer racemes and shorter, broader leaves.

So far as is known at present, this species is confined to the United Provinces, Punjab, Sind and Baluchistan. A full description of it with illustrations will shortly appear in the Indian Forest Records.

The study of the specimens dealt with in this note has shown that the herbarium material of the Indian species of this genus at

Dehra Dun, Sibpur and Kew is in need of critical examination and revision and it is hoped that this may shortly be carried out, but a preliminary inspection of the material now available at Dehra Dun and Sibpur (for the loan of the latter the writer is indebted to Colonel Gage and Mr. C. C. Calder to whom he now tends his cordial thanks) appears to justify the following conclusions :—

(1) The true *T. gallica*, Linn., does not occur in India.

(2) The species hitherto called by this name in the east of the Peninsula, in the Sundarbans and Madras is *T indica*, Willd. and Roxb.

(3) The species hitherto called *T. gallica* in Burma by Kurz and others is doubtful. There are no flowers or fruit of this at Calcutta or Dehra Dun. It is probably *T. indica*, Willd.

(4) What has been hitherto called *T. gallica* in the plains of N.-W. India is *T. Troupii*, Hole.

(5) Considerable confusion has been caused by Aitchison's specimens in Indian herbaria, the identifications of which were published in *Trans. Linn. Soc.* III, 1888, pp 41, 42. Thus Aitchison's No. 32 from Baluchistan was published as *T. macrocarpa*, Bunge. The sheets of this number at Dehra Dun and Calcutta, however, do not belong to *T. macrocarpa* but probably to a form of *T. articulata*, Vahl. The specimens are in leaf only. Again Aitchison's No. 1029 published as *T. gallica* var. *mannifera* and No. 1030 published as *T. gallica*, Linn. var. both belong to the same species as Aitchison's Nos. 285, 286 and 296 which Aitchison published under the name *T. tetrandra*, Pall., and which will possibly prove to be a new species.

The writer has to thank Sir David Prain for very kindly comparing our specimens with the Kew material and for supplying indispensable information regarding the types of various species, also Dr. Daydon Jackson for kindly supplying a photograph of the type of *Tamarix gallica*, Linn.

EXTRACTS.

THE PAPER-MAKING INDUSTRY.

ITS PROSPECTS IN INDIA.

At the Indian Museum on Saturday evening Mr. Raitt, F.C.S., Consulting Cellulose Expert to the Government of India, Forest Department, delivered an interesting lecture on "The Development of Paper pulp Manufacture in India." There was a large audience. Mr. Raitt said :-

In seeking to divert your attention for a short time to this subject some slight apology for its introduction into a series of

lectures such as the present is perhaps called for. I think, perhaps, it is true of the average man to say that paper is one of the daily necessities to which he gives scarcely more thought than to the air he breathes. It is so omnipresent, so all pervading throughout his daily life and activities and withal so cheap—I am, of course, dealing with normal times and conditions—that he never gives a thought to what it means to him in the aggregate or to the nation or the world as a whole, and he may therefore wonder why it should be considered of sufficient importance to be publicly brought to his notice in this form. But we are dealing with a substance which, in the form in which we are most familiar with it, paper, the world uses ten million tons per annum. If we widen our field of view and consider it as cellulose or pulp then we deal with the basic substance of a whole host of other industries of which celluloid, artificial silk, compressed boards or artificial wood, and some forms of explosives are only a few of its many applications and these are increasing in number and importance every day In spite of its apparent chemical inertness, its curious ductility, malleability and capacity for transformation into substances which have not the remotest resemblance to its original form render it quite futile to prophesy where and in what form it will break out next. Even now the cellulose industries as a whole, including paper, come next to cotton manufacture in volume and value among the fibre-using industries. And if volume and value are not enough to interest you then regard for a moment a negative view of the matter. Think of what it would mean to you if it did not possess that attribute which causes you not to think of it—its cheapness! Think of the additional brain fag and worry introduced into your lives if you had to study economy in paper, if you had to borrow newspapers instead of buying them, if you had to consider carefully the cheapest method of replying to a letter, whether you would use the fly leaf of the chit you were replying to or write it across the communication itself, or get the *duftari* to dig you out a scrap of unused paper from the waste-paper basket, or use the backs of last night's bridge-scoring sheets, or write your reply on a slate and send the peon round with it! I

venture to say all this and its cumulative effect would reduce your retiring age by five years if it did not send you, in combination with other things, into eternal retirement before even that reduced retiring period was reached. You therefore owe the paper-maker and his industry some consideration for having saved you from that, and one reason for imposing myself on you this afternoon is that this state of sweet doing nothing, of taking no thought for the morrow, has been and is seriously threatened with disturbance and revolution, for the world's supply of those raw materials now in use has been reduced and continues to reduce in an increasingly rapid ratio, and unless a new source of supply is developed the evils I have hinted at will ere long overtake you.

Then and Now.

There are still a good many men in the street who will reply "rags" if asked what paper is made of, but rag has for long been a quite insignificant item in the quantitative sense. The chief source of supply for 40 years past has been wood, the coniferous wood, and preferably the spruce, of Northern Europe and America, and from this about 75 or 80 per cent. of the world's consumption of paper has been produced. When this industry began the conditions for it were nearly ideal and were fondly regarded as inexhaustible. Enormous areas were covered with spruce and fir on rivers and fiords down which the timber could be floated to manufacturing sites on deep sea water from whence ocean steamers could bear away the product at the lowest possible cost. Then, the competitive demand for it as timber, *i.e.*, for constructional purposes, was negligible, there was more than enough for all; then the world's paper demand was only four million tons; then no one took any interest in the conservation of these forests; so profound was the belief that they were inexhaustible that they were suffered to be swept clean away destroying all hope of natural reproduction, and introducing factors, such as impoverishment aud denudation of soil from absence of natural covering which have converted whole provinces into sun-scorched, frost-bitten, barren wastes where even artificial reafforestation is an almost impossible problem. Now,

the large areas within easy transport reach of factories on tide water are gone for ever and areas still open to those that have survived are at a distance, which has enormously increased the cost of transport of the raw material. Now, the world's demand for paper has increased to 10,000,000 tons and is growing at the rate of 25 per cent. in every ten years, so that in 1928 the demand will be twelve and-a-half million tons, in 1938 nearly sixteen million. Now, the timber demand for constructional purposes has increased so enormously that the pulp-wood limit in size of logs has fallen from 12 inch diameter to 6 inch and even 4 inch in some districts. Now, Governments everywhere are so fully alive to the necessity of forest conservation that restrictions are being imposed on their exploitation. The net result is that in 1913 there was not enough pulp to go round and that prices had advanced during the previous ten years by 25 per cent., that the market could now, assuming normal conditions, absorb an additional million tons, and in 1928 will probably ask for three million tons from a new source of supply. Add to that the permanent increase in manufacturng costs in labour, machinery and freights, which this war has imposed and the time would seem opportune for a large expansion of the industry in new directions and from new sources. I am not going to assert that wood-pulp is in process of rapid extinction. There are still large and untouched reserves of suitable wood in Siberia, Canada, and Alaska, but all at still greater distances from the ulimate consumer and implyng a still greater cost to him, and although wood-pulp will still for a long time be an important factor in our paper supply, yet has it fallen into a secondary position to the rapidly increasing constructional demand, having to content itself with that which the saw-mill rejects. From the point of view of world economics this is its natural position, for it is economically unsound and wasteful to devote a substance which, when applied to construction, can use from 70 to 80 per cent. of the tree, to a manufacture, which, in chemically prepared pulp, can only use 33 per cent. It is a fundamental principle in paper manufacturing that the paper-maker can only use that which is of no interest to anyone else. He is emphatically "a picker up of unconsidered

trifles." As soon as a raw material begins to interest some other industry it ceases to interest him, for these can all afford to pay more for it than he can and we are now seeing this principle receiving a fresh illustration in the case of pulp-wood. Two things are certain : (1) that the days of cheap paper due to wood-pulp—the days when the large London newspapers could buy their supplies for a penny per lb.—are gone for ever, and (2) that wood-pulp has ceased to be sufficient for the world's supply. Here let me interject a note on the *raison d'être* of the pulp industry. Time was when paper-makers produced their own pulp from the raw material, and many of them do so yet, but the introduction of wood as a raw material forced a change of system which has made vastly for economy. Wood, as also the raw materials we shall refer to in this country, requires from 2½ to 3 tons to produce a ton of paper. That in a few words explains the revolutionary change in paper-making methods which arrived simultaneously with the introduction of wood. It is obviously a great economy in transport costs to reduce the wood to pulp at or near the place where the wood grows and to transport the pulp instead of the wood to the paper mill, which is best placed in or near the centres of paper consumption, and so the separation between pulp-making and paper-making proper occurred and is now a permanent feature of the industry as a whole. Similar conditions obtain in India, and we shall accordingly have pulp mills placed in suitable positions close to the raw material supply and sending their pulp to paper mills whose sites are fixed chiefly with regard to the paper markets.

HOW INDIA CAN HELP.

Now we reach the question we are chiefly interested in this afternoon—what can India do to fill the gap which has been created and benefit herself in the process ? The answer is a great deal, a very great deal, though not so much perhaps as I sometimes have assumed. When the threatened shortage of paper supplies was beginning to be agitated some ten years ago I remember an eminent scientist issuing what was intended to be a reassuring statement to the effect that "a proper famine was

unthinkable because paper could be made from any vegetable substance and the world teemed with that." The dictum was seized on by the press and circulated all round the world and no doubt brought much comfort to many an anxious newspaper proprietor. But, like many other assertions of many other eminent scientists, it was considered as cold fact, perfectly true and at the same time considered as a practical contribution to a difficult problem, perfectly misleading and fallacious. Paper can be made from any vegetable substance but money can't. But our eminent scientist's utterance gave rise to a whole crop of wild cat proposals to produce paper from everything, anything and sometimes nothing. I remember one which undertook to produce paper, oil, boots and umbrellas from one and the same plant. Nature, however, is not so fantastically generous as that. He whom she would benefit must delve into her secrets slowly, carefully, deeply; hoping all things, proving all things, until finally he can hold fast to that which is good. This has, in essence, been the principle upon which the investigations of the Forest Research Institute at Dehra Dun, to which I am now about to briefly allude, have been carried on. We have thought it more important in the early stages of our proceedings to save people's money than teach them how to make it, for nothing could be more fatal to the inception of a promising industry than a disastrous failure at the start. At the same time, while paying considerable attention to the how-not-to-do-it programme, we have met with encouraging success on the positive side. Our eminent scientist was an all-in, whole hog, one hundred per cent. man We have knocked ninety-five off that, but remain quite pleased with the five which have survived. The truth is that out of the many thousands of species available a large number have to be knocked out because of the cost of isolating their cellulose, a further large number because the cellulose is no good when you have got it, and others because they grow in economically inaccessible situations not to mention the many species which are too valuable for other purposes to be used for paper. The net result is that so far we have found only two small groups, both belonging to the *Gramineæ*, which are

economically sound as regards the quality of their cellulose and the manufacturing conditions under which they can be handled. These are bamboos and a few, a very few, Savannah grasses. But, though few in number, in the aggregate they mean something considerable. It is, I think, a very modest estimate to say that from bamboo, taking only that which is available under sound manufacturing conditions, Burma, Bengal and South and West India could produce fifteen million tons per annum, and Assam, from Savannah grasses, five millions India could, therefore, produce pulp for the whole world. Consider also the growth conditions under which this is obtainable. To grow a spruce or fir tree to pulp-wood size takes from 40 to 60 years, with the result that a factory which may at its start have its supplies at its back-door finds these year by year receding into the distance with constantly increasing transport costs. Bamboos and grasses come to their full maturity as yearly growths and all you have to be careful of is not to reduce the reproductive vigour of the plant by too frequent cropping. With bamboo this may mean a three to five years rotation and with grasses two to three years, according to soil and climate. We must, therefore, have a sufficient area to exploit to allow of these rest periods, but that only means that for a 10,000 ton per annum output with average figures for yield and rotation a 20,000 acre reserve will keep a factory going in perpetuance, a vastly different condition of affairs from those which govern a wood-pulp installation which lives on its capital from the start.

THE MANUFACTURING SIDE.

On the manufacturing side the Forest Research Institute has succeeded in solving the difficulties which faced it at the beginning of its efforts. The chief of these were two in number: (1) the nodes or knots and their obstinate resistance to penetration by the digestive liquors employed (this has been overcome by the simple operation of totally destroying and opening out their structure by crushing) and (2) the resistance to efficient and economical bleaching. The Institute has at last succeeded in evolving after long and tiresome experiment, a system of digestion which entirely

eliminates this trouble, and pulps can now be produced which are equal to the best wood-pulps in both quality and colour. Some samples are here for your inspection. It is satisfactory to know that the Institute is about to embark upon an extensive enlargement of its industrial exploration activities and that these will include a complete modern pulping plant which will enable its laboratory investigations and results to be repeated, expanded, checked, confirmed or corrected on a scale large enough to permit of factory methods being employed. It will thus become demonstrational as well as experimental and its usefulness, already recognised, will be increased.

I have already referred to the fact that to maintain its usefulness paper must be cheap, cheap enough to waste without giving a thought to it. The waste-paper basket is in effect the paper-makers' best friend. When King Edward inspected the huge mustard works at Norwich he remarked that the consumption must be immense to keep such a large establishment going. "Sir," replied Mr. Colman, "it is not what people use that keeps it going, but what they waste." Paper stands in a precisely similar position. We shall probably never again see the extremely low prices of ten years ago, but the permanent rise in its value, though important to the paper-makers, is scarcely appreciable to the consumer who buys it by the packet, and, if the industry is to continue to maintain its output, it can never be allowed to rise to a point where its user is forced to be economical in its use. The costs of production are, therefore, strictly bounded by a point beyond which the manufacturer cannot go. He is also confined by another limitation to a greater extent than perhaps in any other manufacture, and that is in transport costs. Including his product, pulp he has to transport in and out of his factory no less than 5½ tons for every ton of output ; if he is obliged to use wood fuel this will be increased to 7½ tons. If his transport costs on an average Rs. 10 per ton he may find himself liable to no less than Rs. 75 for transport alone on a product which brings him in, say, Rs. 200, which is an altogether impossible position. This brings me to the second point of my discourse, *viz.*, and nearly equal to it in importance is

that next to raw material that of manufacturing facilities in or near the raw material forests. The finest raw material supply in the world may be of no value whatever unless these are both good in quality and suitably low in cost, and in studying this section of the matter the 5 per cent. we have left to our eminent scientist may undergo further serious reduction. It does not necessarily follow that everything the manufacturer requires must be close to his hand. It may be, and frequently is, the case that some extraordinary advantage of position, say, in raw material, may enable him to pay a little more for his fuel, lime, and other subsidiary materials. It becomes a question of balancing up the transport conditions as a whole in order to arrive at whether a site is a good one or not. Perhaps the importance of this phase of the question will be most tellingly illustrated if I quote my own recent experience. During the past seven years I have been asked to revise some sixteen proposals for establishing the industry in this country. Of these I had to reject only three on account of the raw material supply. Of the thirteen left, nine failed to pass the tests applied to subsidiary materials and transport. Only four out of the sixteen have survived investigation. Judging from inquiries I receive this phase of the matter receives little attention and a suitable supply of raw material seems to be regarded as in itself a sufficient foundation for the industry. I, therefore, desire to issue as a serious warning the statement that no profusion or excellence of raw material is of any value whatever unless it is associated with suitable manufacturing facilities. Such localities do exist in India and Burma, but they have to be sought for, and when found their various factors have to be carefully investigated and correlated before they can be pronounced to be satisfactory commercial propositions.

THE BALANCE-SHEET.

Let me now detain you for a few minutes with the debit and credit side of the subject. Chemically produced wood-pulp costs on the average pre-war for wood alone and ignoring for the moment all manufacturing costs £4-10-0, say Rs. 65 to Rs. 70 per ton of pulp. Bamboo and Savannah grasses, owing to their abundance

and the fact that they reproduce themselves annually and there is no other serious demand for them will, assuming good manufacturing facilities, cost only Rs. 25 per ton of pulp. You have, therefore, at the outset some Rs. 40 in favour of India in this one item alone, and a lot can be done with Rs. 40 in a product which may not cost more than Rs. 90 all told on board steamer or river boat. In a plant producing 10,000 tons per annum this means an advantage of 4 lakhs over a European competitor. Inclusive of water freight to paper mills it will, as far as we can see at present, cost round about Rs. 100 to Rs. 110 per ton delivered to consumer. Its value, pre-war, in comparison with imported wood-pulp was about Rs. 150. After war it is making large reservations for safety to call this Rs. 200 per ton. The increased cost of freight alone from Europe will account for nearly the whole of this rise. The present consumption of paper and paper goods in India is about 75,000 tons per annum. Of this the local paper mills produce 30,000, so there is a further 45,000 tons waiting for them as soon as they are assured of a new local supply of pulp. For the last ten years the local paper industry has been stationary at about 30,000 tons per annum, for the reason that it had reached the economic limit of its present sources of raw material, and even to keep up this output they have been importing from Europe 12,000 tons of wood-pulp— an extraordinary anomaly in a country teeming with raw materials and one that we soon hope to put an end to. I confidently hope to see with the inauguration of a pulping industry a large expansion of the paper output. The market is here already and waiting for it and all that is wanted to enable paper-makers to attack it is a new and local source of material and it is a market which is bound to increase largely in the future. In England the effect of the Education Act of 1870 was to multiply the demand in a few years by ten, and here with the increased attention given by Government and in Native States to education the expansion will be in a like proportion. In the United Kingdom the total annual consumption of paper per head of population is about 50 lbs. Here it is at present less than half a pound, so there is plenty of room for the growth that must come, and remembering Gladstone's

phrase that "the consumption of paper is a measure of the people's culture" we may hope that India's culture will, by this standard, advance by leaps and bounds. I think, therefore, that for some years to come India will absorb all the pulp we can produce. When its production expands beyond this there are Australia, South Africa and the Far East open to it countries towards which India is much more favourably situated as regards ocean freight than Europe or America from which they at present get most of their supplies. And at the long end of the vista I see no insuperable difficulty in supplying Europe or even America. By that time wood-pulp will have still further advanced in value, while India's resources will still be only in the infantile stage and at a cost which, compared with the then cost of wood, will more than compensate for the long ocean freight. It is quite within the bounds of possibility that many here present may live to see India supplying the world with this indispensable commodity—a condition of affairs which, politically, will be much more satisfactory than that we have found ourselves in during the last four years when it has come to us with rather a shock that for our Empire's paper supplies we are dependent almost entirely on the foreigner.

"A NOTABLE PERFORMANCE."

In conclusion let me put in a word for the manful way in which our local paper-makers have dealt with the position created for them by war. You can scarcely imagine more difficult conditions than those they were faced with. Half their supply of raw material (European wood-pulp) cut off and chemicals at anything from five to ten times their previous cost and, in some items, not procurable at all, they have literally scraped the gutters and explored the dust-bins in search of material rubbish which five years ago they would not have thought good enough to throw into their boiler furnaces, and from this they have not only made a usable paper but have kept up their output at its old figure. Knowing something of what all this means I characterize it as a notable and splendid performance. The cynic will say it has paid them very well to do so, but I cannot admit that this in the least detracts

from the merit of their effort. When they started in to do it they could not know what prices were going to be and it is not they who have made prices: these have been made for them by a market which has been competing eagerly for every pound they could produce. They have done well and deserve well of the community, and owing to them our sundried bureaucrats can still deliver their souls in three lines and have the honour to be your obedient servants on a full sized sheet of foolscap and enclose it in an envelope five sizes too large for it! —[*The Statesman*.]

BURMA TIMBER IN THE WAR.

The following is a report by Mr. A. Rodger, Deputy Controller of Munitions (Timber supplies), Burma on the "Supply of Timber to the War Fronts by the Forest Department, Burma." The report is being printed as an appendix to the report on Forest Administration in Burma for the year ended 30th June 1918. As this will not appear for some time, and as the subject is one of immediate interest, we are enabled, by the courtesy of the Chief Conservator of Forests, Burma, to publish it now.

SUPPLY OF TIMBER TO THE WAR FRONTS BY THE FOREST DEPARTMENT, BURMA

I.—Preliminary Arrangements.

At the beginning of 1917 the Government of India were asked to make arrangements to supply timber to the armies in the various fields. The first practical step taken by the military authorities to get into communication with the Forest Department in Burma was the despatch, by a Royal Engineer Officer at Bombay, who was in charge of the collection and despatch of timber overseas, of a list showing the timber that would probably be required, and this was followed by a definite order for about 3,000 tons monthly. A large number of sizes of planks, scantlings, squares and round logs were given, and preparations were made by the Chief Conservator of Forests, in March 1917 to collect the required timber at Rangoon. The first arrangements were made with the

Divisional Forest Officers of Pyinmana, North and South Toungoo, Insein, Tharrawaddy, Zigôn and Prome, and timber began to arrive in April. As there was no Forest Officer at Rangoon who had the time or the establishment to receive the timber, the Forest Research Officer was sent down from Maymyo to undertake this.

II.—Depôts.

We were led to understand that the timber was so urgently required that it would be removed as soon as it had been collected at Rangoon and the first arrangements were made on this basis. A small beginning was made at the Sule Pagoda wharf, where a certain amount of timber of all sizes was collected for shipment from the wharf. The first timber deposited there was mostly bought from the timber merchants of Rangoon, and was principally In and Pyinkado; which had to be bought because the Forest Officers could not get it down in time for the first ship, which sailed about the middle of April. It was recognized that it was essential for economical handling that the railway trucks from up-country should deposit their timber near the shore whence it could be removed easily to the ships. The Sule Pagoda wharf was apparently not suited for a permanent depôt as the Port Commissioners could, as a rule, allow us to have only a limited amount of storage room for a limited time, and a more permanent depôt was made in the Government Timber depôt at Alon. Here the port trust had constructed a main siding, with a number of branches, which led right up to the water's edge, for the collection of stone for the river training works. As they had not used those for some time, they allowed the Forest Department to use them and a depôt was started all round the siding, where the timber, as it arrived, was piled, size by size. It was found, however, almost immediately, that the room available would not be nearly sufficient and the Bombay Burma Trading Corporation, Limited, kindly offered a piece of land on the bank of the Pazundaung creek near Monkey Point. A main siding to the Burma Oil Company's and other works ran along just behind this land, and it was an easy matter to build a branch from this as far as the bank

of the creek. The land has been rented from the Bombay Burma Trading Corporation, Limited, and has proved invaluable. During the early rains of 1917 trucks began to arrive in ever-increasing numbers, sometimes as many as 40 a day, and it was found necessary to build another double siding, and finally a third, as the ground under timber amounted by the end of 1917, to about 12 acres A fourth depôt was opened at the end of 1917 at Botataung on land belonging to the Railway Company, where large quantities of sleepers and of Padauk for ordnance work were collected. A fifth depôt was opened in the hot weather of 1918 at Latter-street wharf for metre-gauge sleepers only. In addition to these a large number of round logs were collected in the yard of the Irrawaddy Flotilla Company's Saw-mill at Alon, where they could be handled by cranes, but this was given up after a few months as it was found that loading of long logs into cargo boats was difficult, and a few Padauk logs only are kept there now.

In 1917, a considerable quantity of timber was collected at Moulmein in the hope that it would be possible to send ships there to remove it. This, however, has been found to be impracticable, and the timber originally collected, as well as large quantities of squares and heavy planks of teak and other woods, and of railway sleepers, subsequently purchased, are now being railed to Rangoon for shipment from the wharves or the depôts.

III.—Unloading, Storing and Loading the Timber.

As the quantity of timber, and number of different sizes that arrived began to increase, the difficulties of collecting and handling them economically at Rangoon increased in proportion. Logs and large squares were the most difficult to handle and the whole of these are now sent to the Sule Pagoda wharf where they can be handled by a steam crane or by coolies. The round logs are stacked and loaded on to trollies for shipment by the steam crane and the squares are loaded and unloaded by coolies, trollies being used to put them alongside the ship at the wharf, Loading is quicker and easier alongside wharves than in the stream, but the room for storage is very limited. As far as space has

been available, sleepers and heavy scantling have also been collected at the wharves, but a large quantity of this material has been sent in cargo boats. At the Alon and Dunneedaw depôts jetties have been built and cargo boats are loaded there with sleepers, scantling and planks. These cargo boats go alongside the ships in the stream or at the wharf. A crane has been brought from Wegyi and is used for handling heavy timber at Dunneedaw. Recently, for example, a raft of Taukkyan squares arrived from Henzada and was put alongside the jetty at Dunneedaw, the squares being lifted out one by one and put on to trollies. When several ships have arrived at one time, there has been great rush to keep them going, and all methods of transport have been employed, rafts, cargo boats, railway trucks and bullock carts and the depôts have had at times to work night and day for weeks on end. All the timber is tallied as it arrives and as it leaves and numerous registers of all kinds are kept up, some 50 to 100 clerks and 200 to 300 coolies being employed in the depôts. All unloading, stacking and loading is done by contract, the rate being per ton, the rate for loading by cargo boat including the hire of the boat for four days. A large quantity of teak, cut to the specified sizes, is purchased from the timber firms in Rangoon. This is passed at the mills by Forest Officers and then loaded on to the ships by the firms, the rate paid being f.o.b. and payment being made on the mate's receipt, so that this is much the easiest way of sending off any of the timber. All timber (except railway sleepers) is marked with the number of the indent, the designation of the consignee and the destination.

IV.—The Munitions Board.

In May 1917, the work of supplying timber to the War Fronts was taken over by the Indian Munitions Board and the Forest Research Officer was appointed Deputy Controller of Timber Supplies under the Board.

Special credit is obtained from the Board and this is allotted to the various Divisional Forest Officers as required. Separate accounts are kept by Divisional Officers and these are audited at

the office of the Deputy Controller in Rangoon [and are then sent on to the Controller of War Accounts, Munitions Board, at Delhi or Simla.

Detailed invoices are posted to each consignee with full details of each consig iment of timber that leaves Rangoon, and these are returned receipted with note of discrepancies. On the receipted-issue vouchers adjustment of the cost is made with the military authorities by the Controller of War Accounts.

V.—The Supply of Timber from the Forests.

The whole of the timber now despatched is supplied on indents received from the Controller, Timber Supplies, Simla, and all the sleepers are purchased and despatched according to similar requisitions from the railway member of the Indian Munitions Board. Large indents are divided up into portions corresponding to the quantities each Divisional Forest Officer can supply and smaller indents are placed in one division. About 30,000 tons of round logs have recently been collected all over Burma and those are held at the disposal of the board for supplying new indents, and also those partly complied with. The timber was at first obtained largely from stock held by local saw-millers and from logs that were got out before the roads were closed by the rains in 1917. Many of the indents received in 1917 were for planks and scantlings of various sizes, but these have been gradually changing until now squares and heavy planks are mostly in demand. Large quantities of teak squares and heavy planks and enormous supplies of jungle wood of the same sizes have been supplied for building wharves and bridges and very large demands were received for smaller timber for hutting, trench work, etc. Bamboos are much in demand for river training works, Kyakatwa of large size being found suitable. Spars up to 60 feet long of Teak and In have been collected by the thousand for piles, Toungoo having sent very fine teak spars and the Ruby Mines splendid In spars of great length.

Telegraph poles, box-woods, teak of many sizes for munitions factories in India, wagon-building timber wood for carts, boats

aeroplanes, engine-shed floors and many other purposes have been collected and sent.

A feature of the demand is the great lengths asked for squares and heavy planks being at present almost always demanded in lengths of 20, 25 or 30 feet or more. This should be especially noted in view of the difficulty that Forest Officers have in inducing contractors to bring out long lengths. The great part of the heavy work in organizing supply was done to begin with by Divisional Officers and their assistants in the Pyinmana, North and South Toungoo, Mu, Katha, Tharrawaddy and Zigôn divisions. Large quantities of timber were also collected and despatched by the Divisional Officers of the following divisions :

Prome, Bassein, Insein, Henzada, Pegu, Nyaunglebin, Thaunggyin, West Salween, Ataran, Shwegyin and Ruby Mines.

As a result of continued large demands the Divisional Officers of Thayetmyo, Lower Chindwin, Meiktila and Mandalay divisions have also provided of late a great deal of excellent timber and it is hoped that supplies may be obtained in the future from even more distant forests. The Divisonal Officers of the Rangoon, Mandalay and Moulmein depôt divisions have also done much valuable work in supervision of depôts and in receiving, passing and despatching timber.

VI.—The Supply of Railway Sleepers.

Arrangements for the supply of railway sleepers are made on behalf of the railway member of the Munitions Board and over half a million had been shipped up to the end of June 1918. Four lakhs of narrow gauge sleepers were supplied in response to an urgent demand and more than half these have now been shipped. Broad gauge sleepers have been ordered to the extent of one lakh a month and these have been arriving at Rangoon with great regularity. Metre-gauge sleepers were not ordered until 1918 but a large number have been already collected, about 50,000 have been sent off, and probably four lakhs will be required. In addition to these thousands of point or crossing sleepers of various lengths, for the metre and broad gauge lines,

have been sent away. Broad gauge sleepers were sent away to the extent of about four lakhs in July, August, and September 1918.

VII.—Species of Timber Supplied.

Teak has been sent in very large quantities for wharves and for railway work and to a small extent for minor works, such as carriage-building, buildings and engine-shed floors. Very large quantities of teak have also been sent to the Munition Factories at Dum Dum, Cawnpore, Jubbulpore, Ishapore and Cossipore. Teak has also been supplied to the Royal Indian Marine at Bombay and Calcutta, to the Calcutta Port Commissioners, the Eastern Bengal State Railway and others and to the arsenal at Rangoon. Padauk has been sent to India and Egypt for ordnance work.

A large percentage of the squares, scantling and planks has consisted of In *(Dipterocarpus tuberculatus)* with a good deal of Pyinkado *(Xylia dolabriformis)*, Taukkyan *(Terminalia tomentosa)*, Kanyin *(Dipterocarpus* sp.*)*, Thitya *(Shorea obtusa)*, Ingyin *(Pentacme suavis)*, Pyinma *(Lagerstrœmia Flos Reginæ)*, Didu *(Bombax insigne)* and also some Zinbyun *(Dillenia pentagyna)*, Thingan *(Hopea odorata)*, Thitka *(Pentace burmanica)*, Petwun *(Berrya Ammonilla)*, Chinyok *(Garuga pinnata)*, Nabe *(Odina Wodier)*, Ranga *(Terminalia Chebula)*, Lein *(Terminalia pyrifolia)*, Yon *(Anogeissus acuminata)*, Bambwe *(Careya arborea)*, Myaukchaw *(Homalium tomentosum)*, Binga *(Stephegyne diversifolia)*, Thitpayaung *(Naucles excelsa)*, Myaukngo *(Duabanga sonneratioides)*, Hnaw *(Adina cordifolia)*, Yamane *(Gmelina arborea)*, Pinlehazo *(Heritiera* sp.*)*, Kokhe *(Bombax* sp.*)*.

The bamboos sent have been principally Myinwa *(Dendrocalamus strictus)*, and Kyakatwa *(Bambusa arundinacea)*.

It has also formed a large part of the total of railway sleepers sent, other important woods being Pyinkado, Taukkyan, Pyinma, Ingyin, and smaller quantities of other hard woods being included.

All important species have been given serial numbers with the letter B, so that they may be marked in the forest or at the mill, and identified and reported on after being in use.

Statement of Timber, etc., supplied from Burma by the Munitions Board and Forest Department, from 13th April 1917 to 13th January 1919.

Country.	Teak, tons.		Other Wood, tons		Bamboos		Sleepers		Total, tons.
	Round	Sawn.	Round	Sawn.	No.	Tons	No	Tons	
Mesopotamia ..	1,166	15,695	720	17,167	1,44,844	3,385	5,42,826	21,749	59,882
Egypt . .	303	238	4	9,411	75,199	752	4,01,086	17,168	27,876
Salonika ..	..		.	10,468					10,468
E. Africa .	..	158	...	...	.			.	158
India . ..	22	7,359	53	741	..	..	5,52,610	35,347	43,533
Aden .		..	..		...	.	16,081	486	486
Total ..	1,491	23,450	787	37,787	220,043	4,137	1,542,003	74,750	142,402

[Note. We have substituted the above statement for that given in the *Rangoon Gazette* up to 30th June 1918 only.—Hon. Editor.]

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THE BOARD OF FORESTRY, 1919.

TRIENNIAL MEETING.

The fourth triennial meeting of the Board of Forestry took place at Dehra Dun between the 31st March and 5th April last; the members being Messrs G. S Hart, C.I.E., Inspector-General of Forests,; T. R. D. Bell, C.I.E., Chief Conservator of Forests, Bombay; C. G. Rogers, C.I.E, Chief Conservator of Forests, Burma; B. B. Osmaston, C.I.E., Chief Conservator of Forests, Central Provinces; P. H. Clutterbuck, C.I E., Chief Conservator of Forests, United Provinces; W. F. Perree, C.I.E., President, Forest Research Institute and College, Dehra Dun; A. W. Blunt, Conservator of Forests, Western Circle, Assam; R. McIntosh, Conservator of Forests, Punjab: F. Trafford, Conservator of Forests, Bihar and Orissa; H. G. Billson, Conservator of Forests, Western Circle, United Provinces; S Cox, Conservator of Forests, Northern Circle, Madras; F. L. C. Cowley-Brown, Principal, Madras Forest College; B. O Coventry, Conservator of Forests, Kashmir; J. L. Baker, Deputy Conservator of Forests, Bengal; and R. D. Richmond, Assistant Inspector-General of Forests,

The proceedings were opened by Sir Claude Hill, K.C S.I., Member of Council in the Revenue and Agriculture Department, who gave the address reproduced below and who, up to the time of his departure on the 2nd April, took the keenest interest in the proceedings. This was followed by an address, also quoted verbatim, by the Inspector-General of Forests. The latter not only outlined the work awaiting the Board but reviewed the progress of research since the creation of the Research Institute and outlined the future developments required both in forest research and forest education.

The business of the Board of Forestry was then proceeded with. Committees were formed to deal with the programme of research work, thereby ensuring detailed examination of the subjects in consultation with the various experts. The programme after consideration in committee eventually came up for final consideration by the full Board This method saves much time and discussion and affords more leisure for the special subjects and papers which have been set aside for general consideration. It must, however, be borne in mind that the Board is an advisory body whose functions are confined to the consideration of the Triennial Programme of Research, the conduct of forest education at Dehra and the discussion of technical matters previously approved by the Government of India. Its resolutions are laid before the Government of India who may invite the opinions of Local Governments on special points before passing orders.

In recording briefly the principal subjects that came up for discussion we take the opportunity of making a few observations which may help to elucidate the proceedings, and also serve to impress upon those who have not had the opportunity of seeing the papers or attending the meetings the main objects which underlie the recommendations made. To most forest officers the aims in view are obvious, but it may be useful to forecast some of the developments that are anticipated and to emphasize the necessity for the course proposed. Much of the ground has been traversed by the Hon'ble Member and the Inspector-General of Forests in their addresses, but too much emphasis cannot be laid on our urgent requirements.

In the strictly technical work of the department, and chiefly in the utilization and sylvicultural sections, we believe that the sectional meetings foreshadowed by the Hon'ble Sir Claude Hill will fulfil a long-felt want, as by frequent meetings in suitable localities, and not necessarily at Dehra, opportunities will be given to those who are chiefly interested of exchanging ideas and of introducing, into actual practice, methods and suggestions found to have answered in localities outside their own. It is obviously beyond the scope of the Board of Forestry to indicate anything further than broad lines of scientific or economic research, the details must be worked out by experts with the help of those responsible for carrying out the work on the ground.

The advantages of a preliminary discussion, prior to consideration by the Board of Forestry, were fully illustrated in one of the subjects, namely, "The methods of collecting and recording Statistical Information in sylvicultural matters" which had been dealt with at a conference held in July last at Dehra Dun. The Board accepted generally the recommendations of the conference which, as regards the compilation of yield tables, were explained in detail by Mr. S. Howard. The main feature of this discussion was the recognition of the necessity for decentralization of sylvicultural research, as it is obviously impossible for any central institution to cope with all the problems connected with tree-growth over a vast and varying country like India. While guiding and advising the local experts in their sylvicultural work, the functions of the Research Institute cannot go beyond the co-ordination and dissemination of the information collected by provincial experts. The debatable question of Forest Journals also came up for consideration, and resulted in the elimination, from existing headings, of much information already available elsewhere and the limitation of their function in future to the recording of facts and figures of actual value in the scientific and economic management of our forests. A more logical sequence of working-plan headings was also agreed upon, while the record of survey work entered in Forest Department Code Form No. 10 was also modified in the light of present and past experience

Mr. Tireman's paper urging a large and immediate increase of *Imperial and Provincial staff to cope with the immediate and* future requirements of the Department resulted in the recognition that the service is much undermanned, although in present circumstances it is difficult to obtain trained probationers. The paper is suggestive of the huge possibilities of our forest resources, which require chiefly additional staff to develop them, and doubtless when this paper is circulated with the Board's proceedings will result in local Governments giving the matter their full consideration. *Mr. Tireman* was unfortunately not present at the meeting. Mr. Gibson's paper on Business Office Methods indicated means of adopting more modern and efficient methods of filing and disposing of correspondence than are usually adopted in Government offices. The principal criticism lay in the absence of a register of receipts and issues of documents which was held to be necessary. The subject is obviously one for detailed consideration by a small select committee composed of a few officers of the Department and one or two business men. In selecting the forest officers it will be necessary to guard against the mistake of selecting officers known to be partial towards office work. The duties of the forest officer lie in the field, and in the consideration of schemes for future economic development he should, therefore, be relieved of the unnecessary trammel of returns, reports, registers, etc., which form a feature of our present methods of office business.

Mr. Cowley-Brown's paper on Future Forest Colleges, coming at a time when the further decentralization of our ranger's education had been agreed upon, afforded valuable hints and conclusions The Madras Government, in placing an experienced officer of the rank of Conservator in charge of its forest college, has shown a just appreciation of the responsibilities attendant upon those entrusted with the training of our executive staff. We realize fully that the separation of the rangers' classes from the control of the Research Institute cannot take place too soon, as the educational work demands the closest attention and associated, as it now is, with research and the education of the provincial staff must result in loss of efficiency through sheer inability to devote the necessary attention to both interests

The Board, in association with representatives of those interested in lac production, including members of Calcutta firms, an expert from Pusa, the Deputy Director of Commercial Intelligence and Director of Esociat Ltd. dealt with "Improvements in methods of cultivating and manufacturing Shellac." The chief obstacles to the introduction of the necessary improvements lie in the fluctuations of the lac market and the location of the principal lac bearing areas outside Government control. It was, however, decided to recommend the conduct of experiments in improved methods of cultivation and collection in certain Government forests and to leave the question of further enquiry, if considered necessary, to the Department of Commercial Intelligence.

The formation of a special Forest Engineering Branch has been a long-felt want, and the resolution of the Board recommending the creation of a special Forest Engineering service, should go a long way towards the realization of the forest resources of India. These resources not only require improved methods of extraction, conversion and transport but an entire new agency to push the manufacture and marketing of existing and new products. The Board accordingly also dealt with the creation of this agency and it was unanimously resolved that new administrative units, styled Utilization Circles, should be established manned mainly by technical experts, to give effect to this policy, which in effect postulates new sources of revenue. In most provinces it will be necessary to establish pioneer factories so as to prove to capitalists that these undertakings are remunerative and also as an index of the terms on which leases or concessions can be made. Closely connected with the development of new forest industries is the supply of skilled workmanship and the Department should, therefore, be associated in schemes of technical education. The example of the United Provinces in transferring to the department the Government Central Wood Working Institute at Bareilly suggests an example that may usefully be followed elsewhere. Not only does such an institution afford means of training the necessary skilled labour but it advances

the solution of economic problems by covering the important stage of commercial research. In this stage articles and products must be manufactured in sufficient quantity to admit of tests under working conditions by consumers. Most wooden articles hitherto imported into India can be manufactured equally well in the country and the above policy all tends to render India less dependent on foreign countries—a policy which recent events have proved to be of paramount importance.

The establishment of sale depôts for Government timber at main business centres also came under review, and it will be interesting to watch the results of the agency recently established by the Government of India in Calcutta, and worked on a commission basis, *for the disposal of timber from the Andamans and from* other provinces who may choose to avail themselves of this opportunity.

In the matter of forest education it was resolved to recommend the admission of thirty students to the Provincial Forest Service course at Dehra Dun from April 1920 onwards.

It is useful to have an insight into the opinions of others on the relations of the department with the commercial world, and Mr. Raitt's paper reviewing present day treatment of applications from commercial interests was illuminating in affording us a criticism based on an insight of opinions gleaned from contact with both sides. The wheels of Government of necessity grind slow—and too often result in loss of opportunity. Mr. Raitt, therefore, advocated short-circuiting existing procedure by enlarging the powers of forest officers and empowering them to deal with such matters without the necessity of existing delays in Government offices. The suggestion has much to commend its acceptance. The Forest Department in at least one province has practically unlimited authority in such matters, and so long as the comforts of the local residents are safeguarded the interests of Government clearly lie in facilitating the attraction of capital for industrial enterprises. An important recommendation, which received unanimous support, was made by Mr. Raitt who advocated an early inventory of our resources so that interested persons

could, at a minimum of expense both in time and trouble, have all the necessary information placed before them. It was agreed that this valuable suggestion could best be entrusted to a small committee who would draw up a scheme outlining the order and the manner in which the idea could best be given effect to.

The meeting of the Board of Forestry thus dealt with a number of important questions which, if its recommendations are accepted, should go far towards important scientific and economic developments. The cry is, however, first for staff, and still more staff, and the set-back caused by the unavoidable cessation of recruitment of Imperial probationers during the war will put back the expansion along scientific and economic lines which the country now stands in the greatest need of. Delay must spell loss of opportunity and we, therefore, trust that no effort will be spared or money stinted to make up for the time lost. The figures of our finances, quoted in the Inspector-General's address below, are indicative of the value of India's forest resources but, as Mr. Hart points out, they are insignificant in comparison with the vast possibilities still untouched. The Forest Department has hitherto been occupied chiefly in creating and organizing a forest estate adequate to the requirements of the country. It has also given a full measure of attention to the restoration of forests which usually have come into its hands in a ruined or semi-ruined condition. The process of restoration has resulted in a multiplication of the value of the forest capital which few have appreciated or even thought of. The time has now come for the realization of the interest on the enhanced capital. To achieve this, scientific and economic expansion must keep place with increased production. The small staff, indifferent equipment and inadequate accommodation at Dehra Dun will require immediate expansion so that research can be securely established and problems dealt with as they arise. It must also be conceded that the provinces must take up their own responsibilities in this direction and employ their own research officers in sufficiently important problems. Moreover, we must exercise foresight and even allow free play to our imagination so that we shall not stand

charged by our successors with lack of appreciation of our responsibilities.

The meeting of the Board of Forestry in 1919 marks one of the most important stages reached in the history of the department. We must either move forward or fall back, we cannot remain stationary. Our chief difficulty lies in convincing others that immediate action is necessary, and however fully we ourselves are convinced of the righteousness of our cause unfortunately we do not always carry conviction with us. Our predecessors have achieved great things in the face of powerful opposition, and our duty lies in redoubling our efforts until we carry conviction, as they did for us. Too much time is now taken up in meticulous detail and criticism with a view to avoiding mistakes. The only safe way of avoiding mistakes is by doing nothing at all. Delays in disposal of forest affairs are almost as formidable as a negative reply as they effectually destroy all interest. By frequent contact, interchange of views and ideas in the manner indicated by the Hon'ble Member in his address, we shall be in a position to present a united front and this will not only serve to carry conviction but will go a long way towards the achievement of the policy of advancement which the department is fully convinced of the necessity for and is eagerly looking forward to.

Address by the Hon'ble Sir Claude Hill :—

"MR. HART AND GENTLEMEN,—It affords me the very greatest pleasure to be here to-day and to have the opportunity—I fear the only one I shall have during my term of office—of attending a meeting of the Board of Forestry, and to make the acquaintance of such of you as represent the provinces here to-day. It is to me a great misfortune that your Board of Forestry only meets once in three years instead of, as in the case of the Board of Agriculture, every other year, for I have seen enough of these meetings to appreciate the very great value which they possess, not merely from the point of view of the results of deliberations—though these are invariably of the greatest possible value—but also in connection with the opportunity it affords to officers prominent in their provinces to exchange

ideas generally with fellow members of the service serving in other provinces and those at this Institute. I have perhaps particular reason for appreciating the value of such interchange of ideas, since I come from one of the two provinces, Madras and Bombay, in which there is a greater degree of self-continence in forest operations. That greater independence is a feature which will increase and develop gradually in the other provinces in India as provincial autonomy increases, but for that very reason the value of such meetings as these is all the greater, and I feel confident that, as provincial autonomy does develop hereafter, it will be found so increasingly desirable to give opportunities for exchange of ideas and information that, instead of having your meetings once in three years, they will, as in the case of the Board of Agriculture, take place at least once every other year. It is perhaps not wholly irrelevant to this subject to refer to the great isolation which characterizes so much of the life of a forest officer, and in all cases in which work is done over long periods in such circumstances there is an additional advantage in convening meetings for discussion. Isolation and concentration on a particular line of work is always apt to induce specialization of thought and sometimes intolerance of view, not that I wish to suggest that that is characteristic of forest officers, since that is very far from being my experience; but I know from my own experience that work on special subjects in lonely conditions tends to narrowness of outlook, for which, so far as my experience goes, there is only one remedy, and that is, rubbing shoulders with others engaged in similar work. This perhaps is an additional argument in favour of more frequent consultations in regard to forest work.

"While I am on this subject, I should like to give you one result of our experience in this matter in the case of agriculture. There we have found that a Board meeting even once every two years is wholly inadequate for the purpose of getting through the work of exchanging ideas, discussing developments and formulating schemes of advance. Indeed, the work three years ago before the Board of Agriculture was so heavy that we were forced into

recognizing that the time had come for inaugurating sectional meetings annually. These sectional meetings, which have enabled specialists in particular lines to meet and discuss their problems, have not only proved of the utmost value to research—whether mycology, entomology or chemistry—but have relieved the Board of Agriculture of no inconsiderable volume of work. I am not quite sure how far the analogy in the Forest Department holds good. It is obvious, of course, that where agricultural research in the provinces is more organized and developed than is the case with forestry, the need for such sectional meetings is more imperative but even in forestry, you have already sylviculturists everywhere who should certainly meet as frequently as possible, and you will shortly have forest engineers in no inconsiderable number; and the development of utilization work will, unless I am very greatly mistaken, compel you to have frequent meetings of your forest economists and utilization officers.

"Before proceeding to other matters, I should like to mark this occasion, being the first since the conclusion of hostilities, by a reference to what the Forest Department has contributed directly in manhood towards the war. 73 Imperial Service officers and 13 Provincial Service officers were permitted to join the Army or accept employment on war work of other kinds. A great many more desired to join up, but this could not be permitted if the work of the department was to be kept going and if the supply of produce for the requirements of the Army was to be maintained. Several military decorations have been earned by our officers but we have unfortunately also to deplore the death of 8 young members of the service, namely, Messrs. Patterson, Alington, Jeffrey, Ellis, Dickson, Gwyer, Donald and Milne, all of whom, except the last two, who died of disease, were either killed in action or died of wounds. 8 Imperial officers also were wounded. And, gentlemen, if I may say so, those who remained behind in India and who have shouldered the burden of the past four years with a depleted staff and an ever-increasing demand on them for work have equally served their country well. Few people appreciate what the additional burden of work has been, whether in the

forests, Public Works or other service in this country, though we all realize the hardship that has been involved in so many cases in being debarred from the taking of leave. I can assure you, however, that the hard work which has been done by all of you so uncomplainingly and cheerfully has been very greatly appreciated by Government.

"I want now to turn for a moment to a matter which is of vital importance to the future, namely, the schemes which are in hand for the enlargement and development of the Forest Research Institute. That Institute is partly concerned with educational work as well as with research. The matter was first considered at an informal meeting about a year ago in this room when we discussed the possibilities of expansion and the general needs of the situation. A committee also discussed the matter last July and drew up a comprehensive scheme which was designed to meet not only immediate requirements but, so far as they can be foreseen, to suffice for the inevitable expansion of the future, especially in relation to research and commercial development. That scheme, which has been referred to local Governments, has not yet been elaborated to a stage when the sanction of the Government of India can be formally secured. It contemplates a considerable strengthening of the sylvicultural branch, a development and division of functions of the botanical branch, the inauguration of regional entomologists, and, under the forest chemist, the appointment of a soil chemist and a distillation expert. On the economic side, we propose to strengthen the forest economist's branch by an assistant, a wood technologist, a minor forest produce expert and experts in subjects such as pulp, tan stuffs and dyes, etc., though some of these may not be permanent appointments. As Mr. Hart will explain to you in greater detail, it is further proposed to modify the administration of the Institute by inaugurating a Council consisting of the President and the heads of branches more or less on the lines of the organization which we have found to work on the whole successfully at Pusa. This development we hold to be justified not only from the point of view of research, in which so much lee-way has to be

made up, but also from the point of view of the educational needs of the Institute. In regard to education I am not in a position to ay so much as I could wish, as things are still at the stage of deliberation, and a very great deal must depend upon what this Institute is in future to be expected to do in the way of education. As you are all aware, in future we hope to arrange to secure that Indians with the requisite qualifications will be associated in forest work in the Imperial Forest Service, and I know that you will all agree with me that in this matter the Forest Service and the forest administration, which we are developing for the benefit of India at large, should be shared with Indian gentlemen of the right stamp. I do not propose here to give a dissertation upon the proposals of the Public Services Commission but it is necessary that I should say that, provided we can find Indians with the requisite qualifications willing to enter the Forest Service, it is our business to arrange for their proper training. The matter presents unusual difficulties in the case of the Forest Service inasmuch as Indians have hitherto, for one reason or another, shown no special desire to undergo a forest training presumably because other lines of service have proved to be more attractive to them. One question of vital importance in the future will be what is the best arrangement for securing the training of our forest officers of the future, whether Indian or British. I think all will agree that training should take place at one place, that all should be trained together, whether it be in England or in India ; and the conditions and circumstances governing such training is a matter of very great importance, regarding which a decision has not yet been reached. So long as there is a possibility of its being decided that such training should take place in India, it will be realized that the contingency is one which has to be borne in mind in reference to the organization of the Institute here, which is the only possible place at which such training could take place outside the United Kingdom. As I have said, that matter is still under consideration. It is one of the many problems arising either directly or indirectly out of the recommendations of the Public Services Commission regarding whose recommendations, as I have said, I do not propose

to detain you with any remarks to-day, since I know the Inspector-General is going to refer to the matter.

"It will be realized from what I have already said that the development of research is one of the subjects to which the Government of India attach the very highest importance It cannot be for a moment pretended that we are in that respect adequately equipped or staffed but it may perhaps fairly be claimed that it is only of comparatively recent years that it has been understood how important research is to forestry and to the exploitation of the enormous forest resources of India to the best possible advantage of the State. In regard to sylviculture, indeed, it may be said that we have made a beginning, but, from the account which Mr. Hart will give you of the history of this Institute, I am afraid it must be admitted that it is only during the past few years that adequate recognition has been given of the need for higher research in chemistry, entomology, botany and so forth. It is because we are coming to realize the importance of this that we have been considering the urgent needs of the moment in the way of increasing our equipment and accommodation ; and to those of you who are here and who have not seen it before, I would suggest that, while in Dehra Dun, you should ask to see the scheme of development which we have under consideration, since the more opinions we have on the subject and the more suggestions that are made, the more likely are we to deal adequately with it and to secure the understanding and sympathy of the department and local Governments.

"I am the more anxious to make clear that in forestry we recognize the need for scientific development in that we are simultaneously taking what we hope will be considerable strides in advance in science as applied to agriculture and industry generally. I dare say many of you have read Sir Thomas Holland's Industries Commission's report and have seen the suggestions which have been made for co-ordinating research generally. We have recently been considering at Pusa the developments which should result there from this movement towards closer co-ordination of research and it has been recognized by the scientists working

there that there is a great deal to be said for closer co-ordination of all allied scientific work, even though specialized under different heads. For example, botany, whether it is agricultural botany or forest botany, and entomology, whether forest or agricultural, must necessarily work in so closely together as to make it almost inevitable that there should be some co-ordinating directorate.

"To those of us who are in a hurry, this perhaps is a misfortune. We should all like to see results quickly but I venture to believe that research officers generally will recognise, even if the public do not that, when we are endeavouring to establish scientific development upon a really sound basis, it is perhaps better to go slow at the beginning rather than to take hasty steps in advance which may have to be retraced. Let me give you an example of what I mean. At our Agricultural Institute at Pusa, we are contemplating, as here, an advance in our botanical and mycological section. If we were looking at agriculture and agricultural botany and mycology alone, it would be easy enough to build the necessary additional laboratories and to engage the necessary additional staff and the thing would be done; but there are factors in the case which necessarily make one pause. It has to be considered firstly, whether for those particular sciences the situation of Pusa is the best possible, or secondly, whether the desirability for co-ordinating research, say, in botany, might not make it desirable to bring agricultural and forest botany into closer contact. It is perhaps preferable to delay progress by a little to thresh out these doubts rather than to go ahead ignoring their existence.

"Turning now to more practical matters, I think you will realize from what the Inspector-General will shortly tell you that considerable progress has been made on the utilization side in the last two or three years. The war has afforded us a stimulus for development of forest produce which has not been neglected and, if anything had been required to hasten the much-needed introduction into India of a staff of forest engineers, the war would have provided the stimulus. I look forward to the time when every

province will have its staff of forest engineers and, as I have already said, when there will be meetings of these at frequent intervals to concert further developments. This alone, coupled with the work of a developed forest economist's branch, can remove the reproach that the low return which we at present get from our forest area in India compares so unfavourably with the corresponding returns of other countries.

"I did not intend to detain you for so long as I fear I have done, since I know you want to get to work and Mr. Hart has a great deal to say to you, but I did want to make it clear that the Government of India attach the very greatest importance to deliberations by the Board of Forestry and that they believe that your discussions will help them very greatly with advice and guidance in steering a course towards more efficient development.

"There is one more point to which I should like to refer. I have read with interest a note by Mr. Pearson, dated the 28th of February last, on the dissemination of information by the Forest Research Institute. Now, as I have so often had occasion to observe before, all Governments, except possibly the more democratic governments of the antipodes, are bad advertisers, and, of all bad advertisers, the Government of India and their allied officers are the worst in the world. Whether we do good or not may perhaps be questioned, but, if we do good, it is certainly by stealth, and, in these days of political reforms and democratic developments, it is no longer permissible to hide our light, if we have any, under a bushel. Here, in this Research Institute—and of Pusa the same tale is told—the results of our investigations and research are so badly advertised that the man in the street questions whether we have any. Mr. Pearson has rightly looked at the matter from a commercial stand-point. After all, our results are intended all the time to produce commercial advantage and we are not doing the whole duty of man unless we attain a certain degree of publicity. It was therefore with very great pleasure that I approved the other day the proposal to issue periodical leaflets an to take the other steps which Mr. Pearson advocated."

Inspector-General's Address :—

"SIR CLAUDE HILL AND GENTLEMEN,—Before proceeding to review the results which have followed the last meeting of the Board in 1916, I wish to express my thanks, in which I know you all join, to Sir Claude Hill, the Honourable Member in charge of the Department of Revenue and Agriculture, for the trouble he has taken in coming to open the fourth meeting of the Board of Forestry on the eve of his departure on leave and for the very interesting address to which we have just listened.

"All of you are familiar with the action taken by the Government of India on the recommendations made by the last Board of Forestry and there are only two points to which I need draw your attention :—

(*i*) We shall discuss again the question of a forest engineering branch of the service. In the meantime I am glad to be able to tell you that considerable progress has been made in dealing with this important subject. Most local Governments have recognized that men of this class are required and have asked for one or more of them. As you are probably aware the Government of India deputed Mr. Leete to study the forest engineering methods employed in America and Canada. In addition to being a senior officer of great experience, Mr. Leete has devoted great attention to matters connected with forest engineering throughout his service and so was particularly suitable to carry out this enquiry. His report, which is a very valuable one, has been received, and the first portion of it is now in proof, while as the result of one of his recommendations the Government of India have asked the Secretary of State to engage for them two consulting forest engineers from America for a period of two years, extendable to three if desired. These consulting engineers will advise the Government of India and local Governments on forest engineering problems and will help

in starting off on the right lines the dozen or so junior forest engineers who, it is hoped, will shortly be recruited and distributed amongst provinces after a period of special training.

(*ii*) In educational matters the position as regards the Provincial Service course has been much improved by the acceptance by the Government of India of the recommendation made by the last Board for the appointment of two Assistant Instructors. For this course we have now two Instructors and two Assistant Instructors, so that, with the research officers delivering short courses of lectures in their special subjects, it is now possible to maintain the standard of instruction at a high level. This is not altogether the case with the Rangers course, which for some time past has been short of one instructor, as the number of officers who have joined the Army and the cessation of recruitment have made it impossible to obtain an officer for this post. The reduced staff has done its best, but there is no doubt that each of the large Ranger classes must have an Instructor and an Assistant Instructor if the teaching is to be kept up to the standard required.

"In addressing the Board three years ago I referred to the question of decentralizing the training of Forest Rangers and expressed the opinion that the scheme would have come into force by this time. The necessity for the curtailment of expenditure caused by the war and the uncertainty as to the arrangements for the future training of recruits for the Imperial branch of the service have prevented this. But decentralization will be introduced to some extent next year, as from 1920 Ranger students from the Central Provinces, Bihar and Orissa, and the Central India States will go to the Madras Forest College at Coimbatore. This will enable the Dehra College to take more students from the other provinces, until the Government of Bombay can construct the proposed Forest College at Dharwar, thus permitting the scheme of decentralized training to be introduced in full.

"One hears from time to time, Gentlemen, whispers to the effect that the department as a whole does not know very much of the work done by the Research Institute. I think, therefore, that it may not be out of place if I give you a short sketch of the principal work done since forest research was first commenced.

"Work in the Chemical branch was started by Dr. Warth in the nineties, and some ten years later a second and more serious attempt was made, though the lack of accommodation and appliances limited the scope of the work to the chemical valuation of materials submitted by various officers and departments. The provision of a laboratory and equipment in 1914 gave the Chemist an opportunity of proving the value of this branch. The demand for analytical work has steadily increased and left the relatively small staff little time for original work. Nevertheless a good deal of investigation has been carried through with the main object of demonstrating on a commercial scale, the possibilities, or otherwise, of developing certain industries. It is possible only to mention a few of the principal investigations. These comprise tanning extracts, chiefly in relation to mangrove bark, and the distillation of turpentine from the resins of Indian pines, resulting in the introduction of the redistillation process in our present distilleries. The possibility of pine needle oil has been fully investigated while the chemical properties of the natural varnish of *Melanorrhœa usitata* have been proved to be identical with Japanese lacquer varnish. The first researches into the manufacture of Thymol from "Ajowain" seeds were made at this Institute and have resulted in the erection of a factory in the Dun which now supplies a large part of the world's requirements. Latterly the manufacture of turpentine, rosin and gum from the gum-resin of *Boswellia serrata* has been investigated and this will, it is hoped, yield important results. A very large number of other minor investigations have been carried out; their number may be gauged from the fact that 57 notes and reports have been prepared, the majority of which have been published. These results must be considered creditable in view of the small staff and the inadequate equipment at our disposal. The Zoological branch was

the next to be started by the appointment in 1906 to the Forest College staff of an Entomologist for educational and research work. Although the title was later changed to that of Zoologist, in point of fact the work has practically been confined to entomology. This work may be divided into three distinct periods. The first from 1906 to 1911, when a general survey was carried out, resulting in the discovery of a large and complex fauna. Scientific research was, however, hampered for want of literature, equipment and authoritative identification. Much general work was taken up though little specialization was possible. Of 34 publications issued to date, no fewer than 26 appeared during this first period. The second period lasted for some two years only; but in it valuable reforms were inaugurated and provision was made for the fundamental requirements of research, comprising a reference collection named by specialists, an extensive library and adequate laboratory and insectary equipment. Valuable investigations were made into the lac insect, the chir scale and the principal borers of Sal, while an extensive collection of termites was gathered in all forest divisions; this last material is being utilized for the volume of the Fauna of India dealing with this group The third period, which brings us to the present time, has revealed that the most productive methods of investigation lie in the consideration of the forest as a biotic association of plants and animals and in the treatment of insects from an œcological standpoint. In considering the œcological position of forest insects on broad lines it was determined (i) that Indian forests are not subject to epidemics under normal conditions, but (ii) that conditions favourable for epidemics and the evolution of new primary pests may be created by the establishment of pure plantations and uniform forests. Thus the large pine bark beetle and its associates, and the 'toon' shoot and fruit borer seem to be results of artificial methods of regeneration. Pests of the natural forest such as the heart wood borers of *sal* and teak and the defoliators of this latter species have been worked out, but such enquiries necessitate the investigation of a complex association of insects and their alternative food plants. Investigations of this kind are therefore

prolonged and remedial measures are not easy of solution or application. The collection of insects has made good progress and now contains 8,000 species. The number of specimens cannot be calculated but about 12,000 are added each year of which fully half are bred in the insectary. The museum and library have expended steadily while there are some 5,000 ledger files. Card indices have been prepared for Indian insect species, food plants, pests of trees, literature, etc.

"In the Botanical section, which started with the creation of the Research Institute in 1906, the work falls under the main heads of education, systematic botany, diseases of trees, and œcology. The educational work has included the publication in 1909 by Mr. Hole of an excellent manual and the botanical work of past students indicates that the teaching has borne good fruit.

"Systematic botany has had for its principal object the dissemination among forest officers and economic workers of a good knowledge of the names and economic uses of forest species, firstly by encouraging the publication of floras and descriptive lists, of which several have been issued by local officers and several more are under preparation, and secondly by identifying specimens for enquirers. For satisfactory identification work a good herbarium is essential as well as a well-equipped library, and since 1906 more than 20,000 sheets have been added to our herbarium, in addition to Mr. Duthie's valuable collections incorporated in 1908. Since 1908, 4,100 specimens have been identified for forest officers and others, and this work has resulted in the discovery of a number of new species, among which may be mentioned species of *Albizzia*, *Spodiopogon*, *Hopea*, *Ixora*, *Grewia*, *Eugenia* and *Tamarix*.

"In dealing with diseases of trees it has been established that the *Trametes Pini* of the Blue pine is conveyed by spores alighting on wounds and can be controlled by the prevention of lopping. As regards the spike disease of sandal, the Forest Botanist has suggested a line of enquiry that may give good results. In œcology the most important work comprises a long series of experiments on the factors influencing the growth of seedlings and has indicated a method of working the *sal* forests of Northern

India which, it is estimated, will reduce the regeneration period by some 35 years.

"The importance of soil aeration, which is now recognized in England and America as a potent factor influencing plant growth, was first brought to notice in India by the Forest Botanist.

"The work, which has been carried out with the help of the Chemical branch, has established the primary importance of this subject in the case of *sal* and probably of other important trees also, and has proved that it can be controlled by suitable sylvicultural treatment: it indicates, also, that the control of the root diseases of *sissu* and *sal* probably lies in the improvement of the soil conditions in the moist type of forest in which these diseases are mainly noticeable. This work, therefore, is of great importance to Indian forestry. Many valuable investigations have also been made, among which may be mentioned those regarding the various types of grassland in their relation to tree-growth, the method of working grasses for paper-pulp, the germination of teak seed, and the seasonal coppicing of this species. For much of this work the department is indebted to Mr. Hole who, with intervals of leave, has held the post of Forest Botanist since 1906.

"When the Research Institute came into being in 1906, Sylviculture and Working Plans were constituted as separate branches. A Superintendent of Working Plans was appointed at once, but the post of Sylviculturist was held successively by the Principal and by the Superintendent of Working Plans, in addition to their own duties, with the result that little or no progress in Sylvicultural work was possible until 1910, in which year a satisfactory start was made in systematic research work. The Sylviculturist's work is partly statistical and partly experimental; in addition all available information bearing on Sylviculture and forest management is systematically classified and recorded and no small amount of the Sylviculturist's time is occupied in supplying officers of the Forest Department with information and advice. Since 1910 altogether 293 permanent sample plots and 74 temporary plots have been laid out and measured, many of them twice. The permanent plots, which are situated in the

Punjab, the United Provinces, Bengal, Bihar and Orissa, the Central Provinces and Madras, are re-measured quinquennially : their object is to ascertain the rate of growth, volume production and intermediate yields of typical forest crops of different kinds. Experimental work is carried out in the Kaunli garden, 10 acres in extent, at Dehra Dun, while a great deal of the earlier preliminary work was located in the Surajbagh garden, afterwards abandoned in order to make room for the Research Institute buildings and grounds. Apart from garden experiments, however, there are numerous experimental plots in the forests which are visited periodically with the view of recording observations. Regeneration fellings on a practical scale, as applied to the *sal*, are studied *in the Thano forest in the Dun, which is under the management* of the Research Institute. The results of Sylvicultural research must necessarily be slow in appearing, since it is frequently necessary to continue experiments for many years before definite results are obtained. Among the published work of the Sylviculturist may be mentioned a monograph on *Pinus longifolia*, notes on the Blue Gum Plantations of the Nilgiris, statistics relating to the teak forests of Burma, a note on drought in the *sal* forests of the United Provinces, a preliminary note on the working of *Dendrocalamus strictus*, as the result of experiments carried out over a series of years, and various papers on other subjects. Statistics based on sample plot measurements have been regularly published since the completion of the first quinquennial remeasurements. When last on leave in 1913 Mr. Troup, who held the post of Sylviculturist from 1909 to 1914 and to whom much of our Sylvicultural progress in due, took the opportunity of visiting a number of continental forests with the object of studying the lastest developments in Sylvicultural systems. The results of this study were published in a very valuable note describing various continental systems of management and containing suggestions for improvements in forest management in India. Some of these suggestions have already been adopted in practice. It was at first the intention to produce monographs on the principal Indian trees somewhat on the lines of that on *Pinus longifolia*. This idea was afterwards

abandoned in favour of bringing out a complete work, in book form, dealing from a Sylvicultural point of view with all the principal trees of our Indian forests and with a number of species of secondary importance. This work, on which Mr. Troup has been engaged for some years, will be published shortly in England. It will embody the results of the Sylvicultural work of the Institute since the commencement and will certainly be of great value to all forest officers.

" It has now been recognized that future progress in Sylvicultural research must depend largely on the extent to which the work can be decentralized. But for the war, with the consequent suspension of recruitment for the Imperial Forest Service and the absence of so many officers on military duty, a good deal more would have been accomplished in this direction, as local Governments are alive to the importance of this branch of research. The ideal is for local Sylviculturists to work in different provinces, with the Forest Research Institute at Dehra Dun as a central agency for co-ordinating their work, recording results and distributing information.

" The first work undertaken in the Economic section was to co-ordinate and arrange all past records and information connected with forest utilization. These records, together with much valuable information collected from time to time by forest officers were further supplemented by the records dealing with forest products which were transferred to the Research Institute on the abolition of the office of the Reporter on Economic products. A further valuable contribution of wood and minor forest product collections was taken over from the Forest College ; these were rearranged and classified during 1910-1911 and have since received many additions.

" The first enquiry of importance was in connection with the manufacture of matches in India. The direct result of this enquiry was the erection of a number of factories, from the working of which the many difficulties to be surmounted when carrying out such enquiries soon became apparent. The next question examined was the antiseptic treatment of timber, dealing with

the best methods of treatment and based on durability tests extending over many years. From the very nature of such an enquiry in India, where the treatment of timber is virtually unknown, definite results can only be obtained years after the initiation of the experiments. Still the work done resulted in the laying down by the United Provinces Government of an extensive plant for treating pine sleepers for the State Railways by the open tank process: this met with partial success, but had to be closed during the war, primarily for want of creosote. Since then the North-Western Railway have prepared a concrete scheme for the treatment of pine and fir sleepers in pressure cylinders and are now advertising for creosote.

"About the same time as the above, a complete scheme of enquiry was drawn up with the object of ascertaining the value of bamboos and grasses for the preparation of paper-pulp. An expert was appointed to carry out the chemical side of the investigation, while the more likely areas were visited by the Forest Economist for the purpose of ascertaining data regarding the yield and the cost of extraction, and of selecting possible factory sites. Even, however, after the collection of what was considered to be conclusive proof that bamboos could be utilized commercially for paper-pulp, no firm took steps to start the industry, and it is only during the last 12 months that anything has been accomplished. There are now at least three companies, or syndicates, taking definite steps to erect plants, and though it is not permissible to state how far they have progressed with their arrangements, it may be assumed that bamboo-pulp will be on the market within the next 18 months to two years.

"Among the minor industries that of pencil-making was examined as early as 1909: but exhaustive experiments with a large number of timbers have shown that with the exception of Baluchistan Juniper, which is not available in commercial quantities, there is no first class pencil-making wood available in India, though several timbers have been found suitable for inferior grade pencils. The pencil-making industry, therefore, is at

present dependent on a Juniper timber from British East Africa for first grade pencils. In 1909 an enquiry was commenced to ascertain whether paving blocks could not be introduced into India: paving blocks were laid down experimentally in Rangoon, but the results were not altogether satisfactory. In 1915 a large number of blocks were supplied free to the Calcutta Corporation and the Bombay Municipality. The Calcutta experiments failed, though it is doubtful if this failure was due to the unsuitability of the blocks, for in Bombay the authorities were so well pleased with the results that they placed an order with the Forest Department for further consignments.

"Experiments were carried out in the laboratory and field to ascertain whether more up-to-date methods for distilling Rosha grass oil could not be introduced, and the results obtained were published. It is understood that a company has been granted a lease in the Central Provinces and is about to erect steam stills; this may lead to important results.

"A number of investigations have been in progress with the object of finding uses for Indian timbers at present not largely on the market, and discovering timbers suitable for special purposes. Thus as far back as 1913 *Anogeissus latifolia* was introduced in the East Indian Railway workshops at Jamalpur for shafts for welding hammers, and many timbers were tested for pencils, pen-holders and rulers, of which a few are at present in use. A bobbin factory, started in Calcutta, used Indian timbers only: these were found quite suitable, but the factory had to close down as no bobbin expert could be obtained in war time. Again three-ply woods were tested for a firm which has since erected an up-to-date three-ply factory. Another timber has recently been tested for rifle stocks which has passed all the workshop tests and is now being given a service trial. Then again, several Indian timbers have been tested for tent poles, boot-lasts, leather-cutting blocks, etc., etc., and some of them have proved to be eminently satisfactory. Many similar enquiries have been in progress; but the above instances are sufficient to show the lines along which work has been proceeding.

"Of recent years the three most important enquiries in progress have been in connection with:—

(*i*) The natural seasoning of timber, (*ii*) *Boswellia serrata* gum-oleo-resin and (*iii*) the possibility of preparing charcoal briquettes. Reports on the first two experiments have been issued and considerable attention is being paid to these subjects; the third enquiry is still in progress. A variety of other experiments have been in hand, often instigated by enquirers, and a large number of mechanical tests have been carried out on timbers, both for constructional and special purposes.

"The results of the more important enquiries have been published. Forest Memoirs have been issued on *sal* timber, Indian woods and their uses and match-making: Forest Records on the antiseptic treatment of timber, the seasoning of timber, bamboos for paper-pulp, tea-box woods and *Boswellia serrata* gum-oleo-resin: Bulletins on a variety of subjects dealing with the mechanical properties of timber, and trade notes, published as Bulletins, on 18 of the more important species of Indian timbers. A Manual on Forest Utilization and a Commercial Guide have also been issued.

"Generally it may be claimed that the work of the Institute on the utilization side has stimulated an interest in Indian timbers and minor forest products, which is likely to have far-reaching effects, and has clearly demonstrated that, provided liberal funds are made available for plant and staff, the returns will be highly remunerative. In 1906 the Economic Branch was unknown Now enquiries are received from all parts of the world and number over 3,000 a year. The start was made by Mr. Troup but Mr. Pearson has been in charge of the Branch since 1909, and the growth and influence exercised by the Branch are largely ascribable to the energy and ability with which he has carried on his duties.

"The staff of the Institute is partly occupied with educational work and the accommodation is limited. The necessity for extension has been recognized by the Government of India for some time past, and this matter was considered last July by a committee over which Sir Claude Hill presided. The scheme has not yet

received the final approval of the Government of India, as, among other things, certain questions regarding the plant required have not yet been decided, while the extent to which the educational side of the Institute may require expanding depends, as in case of the Rangers course, on the arrangements for the future training of Imperial Service recruits. Still I may say that if we get what the Committee decided to recommend, the Institute itself will be converted into a really fine building and the staff of Imperial research officers will consist of :—

(*i*) The Sylvicultural Branch with one Sylviculturist and two Assistant Sylviculturists.

(*ii*) The Botanical Branch with one Systematic Botanist, one Œcological Botanist, one Bacteriologist and one Mycologist.

(*iii*) The Entomological Branch with one Entomologist at head quarters and four regional Entomologists.

(*iv*) The Chemical Branch with a Forest Chemist, a Soil Chemist and a distillation expert.

(*v*) The Economical Branch with one Forest Economist, one Assistant Forest Economist, one Wood Technologist, one Minor Forest Produce expert and experts in subjects, such as paper-pulp and tan stuffs and dyes, for such periods as may be required.

" Each Branch will have a number of subordinate assistants, while the Economic Branch will be equipped with plant sufficient for the production of commercial samples at the least. It is hoped, too, that the Heads of Branches will receive a moderate addition to the allowance now drawn by research officers and that the affairs of the Institute will be managed by a Council consisting of the President and the Heads of Branches. With this equipment, Gentlemen, and with the assistance of local research officers in provinces, we may, I think, be certain that the Forest Research Institute will be placed in a fair way to deal with the many scientific and commercial problems which await solution in connection with the proper development of the forests in the Indian Empire. I have only one other remark to make regarding

the Research Institute and that is that if it is to succeed we must have for the Branches staffed by forest officers, the best and most suitable men that can be found in the service, for unless the men here command the confidence of the Department generally, the Institute cannot fulfil its purpose. I trust that local Governments and their forest advisers realize and will remember this when the new posts are sanctioned and the time comes to select officers to fill them.

"Many things have happened, Gentlemen, in the last three years. As regards the sanctioned strength of the staff a moderate increase has to be recorded. On the 31st of March 1916 this was 235 Imperial Service and 233 Provincial Service officers. It is now 254 and 262 respectively, while the orders of the Secretary of State have not yet been received on one small scheme of reorganization providing for an increase of five Imperial and three Provincial officers in Bihar and Orissa, and two large schemes for Burma and Bombay are likely shortly to reach the Government of India.

The financial results of the Department have again improved considerably. For the year ending the 30th June 1915 the Revenue, Expenditure and Surplus for British India as a whole, including Burma, were Rs. 2,97,00,000, Rs. 1,82,00,000 and Rs. 1,15,00,000 while for the year ending the 30th June 1918 the corresponding figures were approximately Rs. 4,22 00,000, Rs. 2,12,00,000 and Rs. 2,10,00,000. The considerable increases in the price of timber and of forest produce of all kinds, due to war conditions, are responsible to some extent for this large increase in Revenue; but though perhaps we must expect some small set-back the figures quoted are eminently satisfactory as showing the increased volume of the business transactions of the Department. It is not possible to separate accurately the amount of the revenue and surplus derived from the reserved and protected forests from that coming from the unclassed forests. But I shall not, perhaps, be very far wrong if I allot four-fifths to the former class, including the forests in the Andamans, where there are no regular reserves at all. On this assumption the gross and net figures for the year 1917-18 amount to annual returns of 7·5 annas and 3·7 annas

per acre respectively for India as a whole including Burma. These figures may seem very small indeed in comparison with the returns derived from forests in Europe; but it must be remembered that vast areas of our forests in India and Burma are still unprovided with proper means of communications, that other very large areas are protection forests pure and simple, consisting of high mountain ranges either above the limit of tree-growth or so situated that they are never likely to yield utilizable produce, that other very considerable areas are mainly grazing grounds stocked with tree growth of the poorest quality, that large quantities of produce valued at approximately 85 lakhs of rupees are either given free, or sold at privileged rates to right holders and others, and, finally, that methods of concentrated working and the use of mechanical appliances for extraction are still in their infancy. If, however, the general average is low and shows the possibility of very great improvement there are instances in India of very fine returns indeed. Thus for the 6,500 acres of the Nilambur plantation working circle in the south Malabar forest division of the Madras Presidency, the figures in the year 1917-18 were Revenue Rs 3,51,921, Expenditure Rs. 76,389 and Surplus Rs. 2,75,532, showing a net return of Rs. 42·4 per acre per annum. Again for the whole of the forests in the United Provinces, the net return per acre in the same year was 9·9 annas.

"Orders on the recommendations of the Public Services Commission as regards the Forest Department have not yet been issued. But a great deal of work in this connection has been done both by local Governments and by the Government of India, and it is, perhaps, permissible to say that when these questions are finally decided the officers of the Department generally may find their position as regards pay and pension considerably improved. Another result that is certain is that in future the Imperial branch of the service will contain a considerable and increasing proportion of Indian officers. Before the war very few Indian officers had entered the Imperial branch of the service. The reason for this state of affairs was, not that entry to the Imperial branch of the Forest Service was in any way more

difficult for Indians than to any other of the Indian services, but simply that the Indian gentlemen who went to England to complete their education had no use for the Forest Department and perferred serv ces such as the Indian Civil Service, the Public Works Department and the Indian Medical Service. I think I may claim that the British officers of the service are prepared to welcome the entry of Indians of the right kind. But I think, also, that they are justified in doubting whether Indians of that kind are likely to come forward in sufficient numbers, at any rate at first · they know the present and prospective values of the vast Government estates committed to their charge; they know the necessity for the employment of really first class men if these estates are to be properly developed, and, judging by past history, they fear that the forest service is likely to obtain only the class of Indian recruit who is unable to find employment in the Imperial branches of other and possibly more congenial services. We must trust the Secretary of State and the Government of India to see that we do not get men who are unsuited to the work. For the rest we must extend to the Indian recruits the same welcome that we have always given to the European, and we must endeavour by precept and example to instil into them the standards of keenness and efficiency which, I am thankful to say, have always characterized the members of our service.

" War conditions have prevented any rapid development of industries based on the utilization of forest produce. As mentioned previously, the manufacture of paper pulp from bamboos has not yet been started, though various firms have entered into, or are likely shortly to conclude, agreements, with local Governments, and it seems certain that this important industry will soon be commenced in Burma and possibly in Bengal and on the West Coast of the Bombay Presidency. The manufacture of three-ply wood for tea-boxes and other purposes has been started as a going concern in Assam by Messrs Bird and Company, and you will see samples of this material, which seems to be of excellent quality, in the Economic Museum of the Institute. It appears that many of the so-called softwoods, which have hardly been utilized at all

up to the present, can be employed satisfactorily for this purpose, which promises, therefore, to be of great assistance in finding a use for timbers that have hitherto been regarded as more or less worthless. Another big project now rapidly approaching the starting point is that of Messrs. Davenport and Company at Rajabhatkhawa in Northern Bengal. This project is connected with the utilization of the outturn of all woods, other than *sal* from large Buxa reserved forest in the Buxa division of the Bengal Circle. It will embrace plant for the manufacture of three-ply wood, for destructive distillation, for the manufacture of charcoal briquettes and for the production of tannin extracts. Among smaller undertakings I may mention the modern plant installed at Ramnagar in the United Provinces for the extraction of Cutch, and a steam distillation plant for the extraction of Rosha oil, which is about to be erected in the Nimar district of the Central Provinces. Government, too, have not been idle in this matter of commercial forest development The resin industry in the United Provinces and the Punjab has been steadily expanded and, though it has not yet reached anything approaching its full possibility, now yields a gross revenue of over 15 lakhs of rupees. In October last a special forest circle to deal with utilization was sanctioned in the United Provinces, while, in advance of the general reorganization of the staff in Burma, the Government of India have recently agreed to the creation of a similar circle in that province. Bengal, also, has instituted a utilization charge and other provinces will, it is hoped, not be long before they follow the lead thus given them. The plant now under erection by the United Provinces Government at Bareilly consists of a large and up-to-date resin distillery, on the lines of the French plant previouly installed by the Punjab Government at Jalloo which latter will, I understand, shortly be duplicated of a saw-mill to deal with miscellaneous timbers, of a bobbin plant, of kilns for seasoning timber, and of the previously existing wood-working institute, which it is intended to utilize as a centre for commercial research in timbers and for technical education. In the same province the extraction of Stockholm tar from stump wood of

pine fellings has been undertaken successfully, and this promises to develop into an important industry. In Bombay a metre-gauge forest railway some 20 miles in length has been built from the main Madras and Southern Mahratta Railway to Dandeli in the North Kanara division, and one new permanent saw-mill and three new portable saw-mills have been erected. Again a scheme has recently been sanctioned for the departmental development of forest work in the Andamans. This scheme will entail an expenditure of some 12 lakhs of rupees and will undoubtedly be remunerative.

"The most satisfactory development of recent years, and the one which, in my opinion, will exercise the greatest effect on the future of forest development in India, is in Sylviculture. I refer to the now general acceptance of concentrated methods of treatment in place of the so-called selection system. When this system was started very many years ago by the late Sir Dietrich Brandis it was the only treatment possible under the conditions then obtaining. But those conditions have changed greatly. The vast areas with which we have to deal, the want of communications, the sparseness of the forest population, the want of staff and the undeveloped state of the demand for many of our Indian timbers, will necessitate the maintenance of the selection system over very large areas for many years to come and will confine the introduction of more up-to-date methods of treatment to our most productive and most accessible forests. In special types of forest, such as the pure *Pinus longifolia* areas in Kumaon and Jaunsar, treatment on these lines has actually been in force for many years; but when, at the Burma Forest Conference in 1910, Mr. Troup advocated the more general application of the principle to natural mixed high forest, with special reference to the teak forests of Burma, the proposal met with a certain amount of opposition. Now, however, I am glad to say, that the majority of the officers in the service hold that it is not enough to be content with the removal of mature trees of a few of the most valuable species at long intervals, and with occasional intervening climber cuttings and more or less

perfunctory improvement fellings, in the interests of such regeneration as may be able to establish itself in the struggle for existence under natural conditions, which are often far from favourable to the very species we wish to reproduce. We hold, now, that it is our business to exercise more control over nature and to make every acre of such forests, as can be brought under the new methods, bear to its fullest capacity crops of the species which will yield the best results under the local conditions Many difficulties, involving much patient research into local conditions and the characters and requirements of the various species, must be surmounted before we can attain this result. But it is only by first solving the many Sylvicultural problems involved and then by applying the results to contracted systems of management, that we shall be able to get the full possibility out of our forests, to avail ourselves of American and Continental experience in the use of mechanical appliances for the extraction and transport of timber, and to place our less well known timbers on the markets of the world in quantities that will ensure their finding purchasers at profitable rates. On the other hand, the adoption of concentrated methods of working will involve various obligations. In the first place, we must be prepared to put back into the forests a fair proportion of the revenue we derive from exploitation, and so secure the success of regeneration largely by artificial measures. In the second place, it will not be enough to place the timber on a line of rail, or on a seaport, in the form of logs and expect the public to buy it and turn it to use I do not believe there is any reason why India should import timber for any purpose whatever. On the contrary, I hold that in the course of time India should be a very large exporter of timber of many kinds, instead of the best quality of teak, which, with small exceptions, forms practically all the timber that leaves India at present. But if this is to come about Government must be prepared to undertake pioneer work. Large saw-mills must be established and equipped with the most efficient and up-to-date drying kilns, so that timber is made available, seasoned and in the forms in which it can be utilized with the least subsequent trouble to the trade. Again with the saw mills

must be associated plants for wood manufactures, such as veneers, ply-wood, matches, barrels, shingles, etc., etc. As Mr. Leete has pointed out in the report to which I have referred previously, the relations that exist between the development of lumbering and that of the industries which depend on it for their supplies of material, are intimate in Canada and the United States, for the one cannot develop without the other. This must hold good in India also, and if private initiative and capital are insufficient to deal with these matters, Government must either be prepared to take them up, at any rate until the suitability of the timbers for the various uses is proved sufficiently to induce private enterprise to step in, or be content to see the development of its forests postponed indefinitely.

"The position of the Forest Department in India is unique, for by far the greater part of the very extensive and really valuable forest tracts in the country are the property of Government, and so can be managed by the department in the best interests of the country. As I have shown above, the present return derived from the vast forest estate is a very small one; but if, on the one hand, the Government of India and the local Governments are prepared to provide the necessary staff, on terms which will attract men of the class required, and to sink the necessary capital in development; and if, on the other hand, the officers of the department go steadily ahead with concentrated work on the right lines, the future prospects will be very bright indeed. Few, if any, of us will be here to see it: but I think we may confidently look forward to the time when the Forest Department will be one of the greatest and most important services in India and when the revenue derived from the forest estates of Government will be many times greater than it is at present."

POSSIBILITIES OF A FIR AND SPRUCE LUMBER TRADE.

BY E. A. GRESWELL, I.F.S.

As Spruce and Fir have come to the fore under stimulus of the war demand, and working plans of these forests are either being drawn up or are contemplated, it may not be out of place for the writer to put forward a few reflections based on the experience he gained while supervising the munitions timber supplies from the Punjab during 1917 and 1918.

Prior to the war the extensive tracts of Fir and Spruce forests in the Punjab and Kashmir had generally not been touched. Such logs and scantlings as reached the river depôts were the outturn of trees standing in Deodar and Kail forests; these were felled purely for sylvicultural reasons and the price obtained barely covered royalty and extraction charges.

Such was the position up to the end of 1916 when the war demand began In the ensuing two years, approximately 80,000 tons of coniferous lumber were supplied from Punjab depôts to oversea bases and against various Indian indents, an amount in itself possibly less than the total extra tonnage absorbed by the Railways and Military Works Department for overseas and local consumption respectively.

Under this strain the available supplies of Deodar, Kail and Chir were rapidly exhausted and never adequately replaced, proving that the more extensive exploitation of these species is not yet possible. The deficiency, however, was fully made up by the ever-increasing supplies of Fir and Spruce especially from Kashmir. The overseas bases, chiefly Basra, received 20,000 tons of this timber, while the Military Works Department, which came late into the market, used it extensively on temporary barrack construction. The market price of the beam 14′ × 12 × 6′ and over in length and section rose from a pre-war rate of Rs. 5 to Rs. 12 each, and of the log from annas four to Re 1 per cubic foot.

It is, of course, too early to offer an opinion as to its durability in the works on which it has been used. Large quantities were

supplied as crating to Cawnpore factories, and now as tea chests to Calcutta; there is little doubt that for purposes of this nature it has no rival. As lumber for building works, however, local trade opinion has been in the past so antagonistic to its use that its suitability appears open to doubt. While its susceptibility to damp and, of course, white-ant attack is admitted, yet the absence of any proof as to its defects on other grounds justifies the assumption that trade opinion is unduly influenced by a prejudice probably based on its comparative value with that of the other more popular species or on the fact that the supply of these in the past sufficed to meet the local demand. Its known defects are insufficient to debar it completely from use under conditions favourable to durability.

Judging from the absence of complaints against this timber, when properly converted, the war bases have presumably found it satisfactory for building works. This is somewhat negative proof, yet it has been used so largely in Military Works barracks in the Punjab and at Quetta that ample data as to its suitability can, if necessary, be obtained. The most remarkable example of its use is in the new Grand Trunk Road bridge over the Haro, between Serai Kala and Campbellpur, in which the whole of the decking and part of the trestle-work is composed of Fir and Spruce supplied from Messrs. Spedding & Co.'s Saw-mills at Jhelum.

It is also interesting that three English saw mill foremen who have visited these mills during the past year have expressed the opinion that there is no apparent difference between the Himalayan species and its European equivalent.

The suitability of Spruce for aeroplane construction was investigated by the aeroplane timber expert early in 1918, but his decision was unfavourable partly because of knots and partly because of short length. The only timber then available for inspection were some poor quality Kashmir Departmental logs and the ubiquitous beam from which nothing can be expected. There is little doubt, therefore, that the decision passed was premature. The Spruce logs which arrived subsequently from Messrs. Spedding & Co.'s forests in Kashmir were of magnificent quality and

undoubtedly up to specification; moreover, there is hope that some of the Kashmir forests at least can supply logs of the desired length even under the present methods of extraction.

The matter is worth further investigation more especially as the Himalayan Spruce is the longest fibred of all Spruces. At the same time the specification is so severe that the production of aeroplane Spruce alone is at present not a commercial possibility but can be worked only as an adjunct of an ordinary lumber business. The prospect of the infinitesimal yield of suitable timber obtainable militated largely during the demand against any further investigations into the possibilities of working standing Spruce. The extent of wastage can be gauged by the fact that in the earlier types of aeroplane the amount of finished Spruce timber was 20 cubic feet to produce which over 150 cubic feet of selected Sitka Spruce planking was required.

Unfortunately, the increased output of this timber has been devoted almost entirely to military consumption with the result that its possibilities have not been introduced to Indian markets outside the Punjab. Nevertheless samples sent to Calcutta in 1917 and 1918 drew an offer for long length slabs of over Rs. 3 per cubic foot f. o. r. Calcutta or, say, about Rs. 2-8 f. o. r. Punjab. This is, of course, an inflated rate but affords some proof that Fir and Spruce could, with freightage preference under normal conditions, compete successfully with imported Japanese Pine in the markets of Northern India.

It is a remarkable fact that a timber, so well known in the British lumber trade, is hardly recognized in India outside the Punjab. It is understood that in such adjacent territory as Sind and Baluchistan Fir can be substituted for Kail or Chir without comment. In the Karachi market all coniferous lumber was still quite lately known as Deodar and demanded a special rate apparently based on the rates of sea-imports. Again, Ordnance factories know only of Deodar and Chir, other coniferous species being covered by the vague term 'deal.'

It is clear from this that the Punjab trader has been in the past blind to the existence of other markets than the Punjab

bazaars, though a part of the blame is attributable to the petty quantities in which he deals, and to the high rates of railway freightage. It was not till a Bombay firm, early in 1917, had cornered the whole Deodar market, while another firm had, with considerable professional enterprise, passed off a large quantity of Fir sleepers as a suitable substitute for Sal that the local trader began to grasp the connection between his timber and the war. He has, moreover, little sense of combination or initiative and has therefore been an easy victim not only of his own failings, but also of the unsympathetic attitude of Government in meeting grievances which are often only too just.

For the promotion of trade Government activity is called for, and in this sphere the Kashmir Forest Department has already shown great enterprise. Being unable to find a sale for its Fir and Spruce a lease was issued to Messrs. Spedding & Co. at rates sufficiently low to cover the initial expenditure of erecting saw-mills at Jhelum and to compensate for possible failures in the pioneer work contemplated. These mills have now been working for two years and have been of incalculable assistance to munitions supply. They give a monthly output of 1,000 tons lumber, and are fitted with additional machinery for finishing and joinery work. This example is both instructive and refreshing, and judging from the excellent and previously unknown quality not only of the logs exploited but also of the outturn, it is safe to predict the complete success of the Kashmir policy.

As indicative of the future policy of Government, the writer may be forgiven for emphasizing his firm conviction based on two years' experience of the timber which reaches the river depôts and of the conversion of the same that it is only from long logs and large squares that satisfactory lumber of any description can be obtained. This applies to all Pine timbers but especially to the Fir and Spruce, which are the only species in which a surplus for export exists. If this is accepted, it is clear that greater attention must be paid to exploitation. At present logs, and these mostly in short lengths, are to be found only on the Jhelum and Indus rivers, while the vast majority of timber is brought

down in the form of more or less carelessly converted and often shattered scantlings of 10″ × 5″, 10″ × 6″ and 12 × 6″ section in lengths from 9′ 6″ (Railway sleeper) to 16′. The production of timber in this form is inevitable under the present difficulties and methods of extraction, but if allowed to continue will retard the development of the Punjab lumber trade. Special stress is laid on this point because the true interests of the trade are apt to be clouded by the present and possible future high rates to be procured on the market and the danger that the Forest Department, owing to these rates, will either do nothing or will allow its attention to be diverted to interfering, under the semblance of pioneer work, in commercial activities which are not part of its true function and for which it is in no way fitted.

The greatest assistance which Government can now give in the development of the lumber trade lies in the improvement of all processes of conversion, extraction and grading up to delivery of the timber in the sale depôt. These improvements, at least on the Beas and the Sutlej rivers, are believed to involve severe engineering problems and heavy expenditure on permanent works, all of which are obviously beyond the capacity of the forest contractor. His existence is, in fact, a menace to trade development, and it will not be till the whole of his work has been taken over by Government with the honest intention of carrying out these improvements, not with the object of pocketing his profits, that progress will be made. The advantages derivable from the retention of such a monopoly by Government are too obvious to be enumerated.

In this connection the opinion of an officer for some time in the early part of the war responsible for Indian timber supplies to war bases is valuable as an independent summary of the situation:—

"If only India could supply more seasoned timber and timber in better lengths, the work would be much easier, but Government seems to have systematically starved the Forest Department so that there are no means of drawing out big logs and all the business seems to be in the hands of petty traders."

THE GROWTH OF SAL FROM BROADCAST SOWINGS.

BY G. M. COOPER, I.F.S.

In view of the, as a rule, very indefinite results obtained in attempts at artificially regenerating Sal either by planting or sowing the following results of the broadcast sowing of Sal should prove of interest.

In the hot weather of 1913, some ten acres of an old 'toila' (Chhana toila) in the Sulia Reserve of Nayagarh Feudatory State, Orissa, were sown up broadcast with Sal seed. The following table shows girth and height measurements of 50 average stems in this area taken on the 20th January 1919, *i.e.*, five years and eight months after the sowing :—

Serial No.	Girth in inches.	Height in ft. and inches.	Serial No.	Girth in inches.	Height in ft. and inches.
1	6·75	12 10"	26	4·50	13
2	6·62	14 9"	27	6·50	14
3	7·37	14	28	4·87	10 6"
4	6	12	29	4·25	10
5	4·25	11	30	5·75	14 5"
6	5·37	11 4"	31	4·87	11
7	5·12	12 3"	32	5·37	13 3"
8	4·37	9	33	7·12	15
9	6·12	12 8"	34	2·50	8
10	3·37	7 8"	35	4·75	14 6"
11	5	10 6"	36	6·37	13 4"
12	4·12	9 8"	37	6·12	12 4"
13	5·37	13 3"	38	5·62	12 8"
14	5·75	13	39	5·50	13
15	6·25	13 4'	40	5·62	13
16	4·62	11 2'	41	5·62	13 6"
17	3·12	10	42	4·50	13 6"
18	3·62	10	43	4	11 6"
19	3·75	11	44	6·62	12
20	5·37	13	45	5·75	12
21	5·37	14	46	5·87	15
22	3·62	10	47	4·50	12
23	5	12 6"	48	5·62	13
24	5·62	13 6"	49	3·75	10 6'
25	5·75	12	50	4·87	13 6'

This gives an average girth of 5′ 17″ and an average height of 12′ 2″ for the plot measured.

A brief history of this plantation is as follows :—

The area was an old 'toila' or 'jhum' very open and grassy but with a very scattered bush and small tree-growth of *Woodfordia floribunda*, *Zizyphus Jujuba*, *Cleistanthus collinus*, *Lagerstrœmia parviflora*, *Terminalia tomentosa*, etc., but no Sal. Ten acres of this were thrice ploughed over in the hot weather of 1913 and sown up profusely with Sal seed broadcast. The existing open secondary growth was not cut back in any way but left to afford some shelter and protection. On examination after the rains of that year results appeared poor and the operation more or less a failure. The writer inspected it in the rains of 1916 and then found a profuse growth of young Sal up to 4' in height. None of the plants appeared to be fully established or to have formed definite leading shoots, and were made up of two or more non-erect non-persistent shoots coming up in dense spear grass growth about 3' high. No weeding or attention appeared necessary or desirable and the area was left entirely to itself except that it was, of course, carefully fire-protected. The writer again visited the place in November 1918 and found a fine crop of Sal saplings almost all fully established with characteristic 'carrotty' bark, healthy and vigorous. One particularly fine stem measured 12" in girth and was by ocular estimate nearly 20' high. The old open crop was now found in many cases to be interfering with the leading shoots of the Sal and to need careful cutting back. The factor of stocking might be put at least ·8 or rather nearly full, though it is at the present time difficult to say what a fully stocked crop of this age really is. Instructions were given for the formation of a sample plot here as an opportunity was offered of recording measurements from the seed upwards, and these measurements given in the table above show what Sal can do in less than six years from the actual seed.

On the strength of the results noted in 1916, a further ten acres of blank area in the Hathimunda Reserve of this State were similarly sown up in the hot weather of 1917. This area, when visited in November 1918, appeared at first sight to be covered with a dense growth of spear grass only, upwards of 4' high

Closer inspection, however, showed a plentiful crop of young plants from 6"—2' 6" *in height coming up in the grass, all seemingly* healthy and strong. This grass growth was so rank that it was thought advisable to free out the actual tops of the young plants by merely pushing the grass aside or by slight cutting. On its present showing this area should give even better results than those recorded for Chhana toila. The cost per acre of the sowing and plouging worked out *to less than* Re. *1-8-0 in both cases.* The soil might be classed as a sandy loam. Similarly sowings made elsewhere, though none of them so old as the Chhana toila, have almost all met with results except on the poorest soils and particularly lime rich soils. On a 'genguti' or 'ghooting' soil results are practically nil. This soil appears extremely unsuitable *to Sal, and even when it is found growing on it it is very stunted* and shows no height-growth.

This method appears to be an excellent and inexpensive means of introducing Sal in deserted village areas, old 'jhums' and podas' and blanks in a Sal crop where there is anything like a suitable soil and where climatic conditions are similar.

THE FOOD PLANTS OF INDIAN FOREST INSECTS.

BY C F.C. BEESON, M.A., I F.S., FOREST ZOOLOGIST.

PART III.

(*Continued from* Indian Forester, *pp.* 139—153.)

CHRYSOMELIDÆ.

Aspidomorpha sanctæcrucis, Fabr.

Defoliator.—Convulvulaceæ,[28] *Tectona grandis*.

Distribution.—[India; Burma.]

Blepharida hirsuta, Jacoby.

Defoliator.—*Boswellia serrata*.

Distribution.—Bombay

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[28] Anon., 1915, J.B.N H.S, XXII, No. 4, p. 767.

Calopepla leyana, Latr.

Defoliator.—*Gmelina arborea.*

Distribution.—[Bombay ; Assam ; Bengal ; U. P.].

Clitea picta, Baly.

Defoliator and shoot borer.—*Ægle Marmelos.*

Distribution.—[N. India.]

Colasposoma semicostatum, Jacoby.

Defoliator —*Citrus Aurantium, Vitex Negundo.*

Distribution.—[Sikhim; Mungphu , Cachar]; Siwaliks, U. P.

Corynodes pyrophorus, Parry.

Defoliator.—*Cordia Myxa, Jasminum arborescens.*

Distribution. [Himalayas; Nepal; Assam; Burma; China]; Siwaliks, U. P.

Crioceris impressa, Fabr.

Defoliator.—*Ficus elastica, Holarrhena antidysenterica.*

Distribution.—[India ; Burma ; Ceylon ; Andamans ; Malaya ; etc.]

Criocerus quadri-pustulata, Fabr.

Defoliator.—*Terminalia tomentosa, Trewia nudiflora.*

Distribution.—[Tenasserim ; Siam ; Java] ; Siwaliks, U. P.

Cryptocephalus pusænsis, Jacoby.

Defoliator.—*Tamarix gallica.*

Distribution.—[Pusa.]

Diapromorpha turcica, Fab.

Defoliator.—*Acacia Catechu.*

Distribution.—[India ; Ceylon.]

Estigmena chinensis, Hope.

Defoliator and shoot borer.—*Dendrocalamus strictus, Cephalostachyum pergracile.*

Distribution.—[Bombay ; Madras ; Berar , Burma.]

Eubrachis indica, Baly.

Defoliator.—*Æsculus indica.*

Distribution.—[Kashmir; Himalayas; Mussoorie; N. India]; Bashahr, Punjab.

Melasoma populi, Linn.

Defoliator.—*Salix elegans, Salix babylonica, Populus ciliata.*

Distribution.—[Europe, Asia]; N.-W. Himalayas.

Mimastra cyanea, Hope.

Defoliator.—*Grewia asiatica, Pyrus communis, Pyrus Pashia.*

Distribution.—W. Almora, Naini Tal, Siwaliks, U. P.

Platypria andrewesi, Weise.

Defoliator.—*Zizyphus Jujuba*

Distribution.—[India.]

Platypria hystrix, Jacoby.

Defoliator.—*Erythrina indica,*[24] *Sesbania grandiflora.*

Distribution.—[Ceylon; S. India]; W. Almora, U. P.

Podontia quatuordecim-punctata, L.

Defoliator.—*Spondias mangifera, Ficus elastica.*

Distribution.—[India; Andamans]; N. Toungoo, Burma.

Sagra femorata, Drury.

Stem borer.—*Mucuna atropurpurea.*

Distribution.—[India; China; Borneo; Java.]

Sagra longicollis, Lacord.

Wood borer.—*Tectona grandis.*

Distribution.—[Assam]; Katha, Burma.

Sagra jansoni, Baly.

Wood borer.—*Tectona grandis.*

Distribution.—[Madras], Tharrawady, Burma.

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[24] Fletcher, 1917, B. pp. 74—77

CISTELIDÆ.

Cistelomorpha andrewesi, Fairm.

Defoliator.—*Pinus excelsa.*
Distribution.—Chakrata; Siwaliks, U. P.; Simla, Punjab.

Cistelomorpha annuligera, Fairm.

Defoliator —*Cedrus Deodara, Pinus excelsa.*
Distribution.—Chakrata, U. P.

CURCULIONIDÆ

[Distribution according to Marshall, G. K. (1916), Fauna of British India, Curculionidæ, Part I.]

Alcides affaber, Fst.

Shoot girdler.—*Ficus bengalensis.*
Distribution.—Bengal.

Alcides frenatus, Fst.

Shoot borer.—*Mangifera indica.*
Distribution.—[Bhamo, Burma]; Bengal.

Alcides ludificator, Fst.

Sapling borer.—*Tectona grandis.*
Distribution.—Katha, Pyinmana, Toungoo, Ruby Mines, Burma.

Alcides porrectirostris, Mshl

Seed borer.—*Juglans regia*
Distribution.—Bashahar, Punjab.

Alcides westermanni, Boh

Shoot girdler.—*Ficus religiosa.*
Distribution.—Chakrata, Mussoorie, Naini Tal, Siwaliks U. P.; Lebong.

Apoderus bistriolatus, Fst. [25]

Leaf roller.—*Prunus Padus, Quercus dilatata, Quercus incana.*
Distribution.—N.-W. Himalayas ; Kangra, Punjab.

Apoderus blandus, Fst.

Leaf roller.—*Dalbergia Sissoo.*
Distribution.—[Burma] ; Pusa ; Siwaliks, U. P.

Apoderus dentipes, Fst.

Leaf roller.—*Desmodium* sp., *Quercus dilatata.*
Distribution.—[India ; Burma] ; Chakrata, U. P.

Apoderus sissoo, Mshl.

Leaf roller.—*Dalbergia Sissoo.*
Distribution.—Kangra, Kulu, Bashahar, Lahore, Punjab ; Kumaun, Garhwal, Siwaliks, U. P.

Apoderus tranquebaricus, Fabr.

Leaf roller.—*Terminalia Catappa.*
Distribution.—[S. India] ; Kanara, Bombay.

Astycus aurovittatus, Hell.

Defoliator.—*Tectona grandis.*
Distribution.—[Madras ; Mysore ; Coorg.]

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[25] This species is referred to in "Indian Forest Insects," pp. 416—418, as *Apoderus incana*, Stebbing. In a letter, dated 9th November 1915, Dr G. K. Marshall informs me that he considers *incana*, Steb., to be a synonym of *bistriolatus*, Fst. The synonomy of the species (in departmental literature) is as follows :—

Apoderus sp., Stebbing, Ind. For., XXIX, p. 104.
Apoderus incana, Ms. Stebbing, Deptl. Notes 1903, pp. 189—192, Plate VIII, Figs. 7 a—c.
" Stebbing, Man. For. Zool., 1908, p. 103, Plate XLI, Fig. 206.
" Stebbing, Ind. For. Ins. Col., 1914, pp. 416—418, Fig. 281.

Astycus chrysochlorus, Wied.

Defoliator.—*Hevea braziliensis*,[26] *Pithecolobium Saman*.[27]

Distribution.—[Madras; Bengal; Assam; Sikkim; Burma]; Malaya.

Astycus lateralis, F.

Defoliator.—*Camellia Thea*,[28] *Tectona grandis*.

Distribution.—[India; Burma; Siam; Malaya.]

Atmetonychus peregrinus, Olive.

Defoliator.—*Prunus communis*, *Prunus persica*, *Mangifera indica*, *Zizyphus Jujuba*.

Distribution.—[Punjab; U. P.; Bihar; Bengal]; Katha, Burma; Seoni, C. P.

Attelabus discolor, Fabr.

Leaf roller.—*Anogeissus latifolia*.

Distribution.—Bombay; South Coimbatore, Madras.

Attelabus octomaculata, Jekel.

Leaf roller.—*Grewia tiliæfolia*.

Distribution.—South Coimbatore, Madras.

Brachyxystus subsignatus, Fst.

Defoliator.—*Abies Webbiana Cedrus Deodara*, *Picea Morinda*.

Distribution.—N.-W. Himalayas of Punjab and U. P.

Cercidocerus bimaculatus, Boh.

Defoliator.—*Dalbergia latifolia*.

Distribution.—Coimbatiore, Madras; Siwaliks, U. P.

Conarthrus jansoni, Woll.

Shothole borer.—*Shorea robusta*.

Distribution.—[Assam.]

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[26] Green, 1916, p. 628. [27] Fletcher, 1917, p. 38. [28] Barlow, 1899, p. 184.

Conarthrus vicinus, Woll.[29]
Shothole borer.—*Dendrocalamus strictus*
Distribution —[India , Burma ; Cochin China.]

Cryptorrhynchus raja, Steb.
Wood borer.—*Pinus excelsa.*
Distribution.—Chamba, Tehri Garhwal.

Cryptorrhynchus brandisi, Steb.
Wood borer.—*Pinus Khasya, Pinus longifolia, Tectona grandis.*
Distribution —Himalayas, U. P. and Punjab ; Chamba, Garhwal ; Shillong, Assam ; Tharrawaddy, Burma.

Cyrtepistomus pannosus, Mshl.
Defoliator.—*Tectona grandis.*
Distribution.—Berar, Jubbulpore, C. P.

Cyrtotrachelus dux, Boh.
Wood borer.—*Dendrocalamus Hamiltonii.*
Distribution.—[India ; Burma.]

Cyrtotrachelus longipes, Fabr.
Wood borer.—*Dendrocalamus strictus, Melocanna bambusoides.*
Distribution.—[India ; Burma.]

Dereodus mastos, Hbst.
Defoliator.—*Acacia arabica.*
Distribution.—[Madras ; Ceylon.]

Dereodus pollinosus, Redt.
Defoliator.—*Pyrus Malus, Shorea robusta, Zizyphus Jujuba.*
Distribution —[Baluchistan ; Punjab ; Kashmir ; Almora, Kumaon, Jaunsar, U. P. ; Nepal.]

Emperorrhinus defoliator, Mshl.
Defoliator.—*Alnus nitida, Prunus armeniaca, Pyrus communis, Pyrus Malus.*
Distribution.—[Punjab ; Sikkim ; Assam.]

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[29] *Conarthrus affinis*, Woll. of Stebbing, 1914, p 454

Episomus lacerta, F.

Defoliator.—*Dalbergia paniculata*, *Erythrina indica*, *Tectona grandis*.

Distribution.—[Bengal; Bombay; Coorg; Madras.]

Eugnamptus marginellus, Fst., Var. **semirufus**, Fst.

Defoliator. *Mangifera indica*.

Distribution. C. P.

Eugnathus curvus, Fst.

Defoliator.—*Butea frondosa*.

Distribution.—Siwaliks, U. P.; Assam.

Himatium asperum, Marshall.

Shothole borer.—*Shorea robusta*.

Distribution.—Goalpara, Assam.

Hylobius angustus, Fst.

Shoot girdler.—*Pinus excelsa*.

Distribution.—Chakrata, U. P.

Hypomeces squamosus, F.

Defoliator.—*Bombax malabaricum*, *Hevea braziliensis*,[30] *Hibiscus rosa-sinensis*.

Distribution.—[Burma; Siam; Cambodia; Malaysia; China.]

Leptomias bipustulatus, Fst.

Shoot girdler.—*Gardenia turgida*.

Distribution.—[Chamba, Dalhousie, Punjab; Almora, Kumaon, Siwaliks, U. P.]

Myllocerus catechu, Mshl

Defoliator.—*Acacia Catechu*.

Distribution.—[Poona, Bombay.]

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[30] Green, 1916, p 628

Myllocerus discolor, Boh.

Defoliator. *Ægle Marmelos*,[31] *Eriobotrya japonica*,[32] *Mangifera indica*,[33] *Psidium Guava*,[34] *Zizyphus Jujuba*.[35]
Distribution.—[Punjab ; U. P. ; Bengal ; Madras.]

Myllocerus discolor, Var. **uniformis,** Mshl.

Defoliator.—*Dalbergia Sissoo*.
Distribution.—[Jaunsar, U. P.]

Myllocerus discolor, Var. **variegatus,** Boh.

Defoliator.—*Acacia Intsia, Dalbergia paniculata, Tectona grandis*.
Distribution.—[Bombay ; Madras ; Ceylon, Burma.]

Myllocerus fabricii, Guer.

Defoliator.—*Acacia* sp., *Casuarina equisetifolia*.
Distribution.—[Madras , Bengal.]

Myllocerus lefroyi, Mshl.

Defoliator.—*Butea frondosa, Prunus Cerasus*.
Distribution.—[Siwaliks, U. P. ; Bengal.]

Myllocerus lineaticollis, Boh.

Defoliator. *Bombax malabaricum*.
Distribution.—[Bombay ; Madras , Assam.]

Myllocerus pustulatus Var. **maculosus,** Desbr.

Defoliator.—*Dalbergia Sissoo, Mangifera indica*[33], *Psidium guava*,[34] *Pyrus Malus, Zizypus Jujuba*.[35]
Distribution.—[Punjab , U. P. ; Bengal ; Madras.]

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[31] Fletcher, 1917 p 216
[32] ,, ,, p. 250.
[33] Fletcher, 1917 p 219.
[34] ,, ,, p 231.
[35] Fletcher, 1917, p 225

Myllocerus sabulosus, Mshl.

Defoliator.—*Casuarina equisetifolia, Mangifera indica, Psidium Guava, Zizyphus Jujuba.*

Distribution.—[Siwaliks, U. P, Bengal; Madras.]

Myllocerus setulifer, Desbr.

Defoliator.—*Dalbergia Sissoo, Rosa* spp.

Distribution.—[Siwaliks, U. P.]

Myllocerus transmarinus, Hbst.

Defoliator.—*Dalbergia Sissoo; Zizyphus Jujuba.*

Distribution.—[Punjab; U. P., Bengal, C. P, Bombay; Madras.]

Myllocerus viridanus, F.

Defoliator.—*Psidium Guava, Tectona grandis.*

Distribution.—[Madras; Cochin; Mysore; Ceylon.]

Pachyonyx quadridens, Chevr.[36]

Gall former.—*Butea frondosa.*

Distribution.—Khandesh, Bombay; Jubbulpore, C. P.

Peltotrachelus [Platytrachelus] juvencus, Fst.

Defoliator.—*Acacia Catechu.*

Distribution.—Bombay; Siwaliks, Kheri, U. P.

Phæomerus angulicollis, Mshl.

Shothole borer.—*Heritiera Fomes.*

Distribution.—Sunderbans, Bengal.

Phæomerus brevirostris, Mshl.[37]

Shothole borer.—*Shorea robusta.*

Distribution.—Jalpaiguri, Buxa, Bengal.

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[36] This species is probably identical with that referred under the name of *Larinus?* sp. (The Palas tree gall weevil) on pp. 410—412 of Indian Forest Insects.—C.F.C.B.

[37] Marshall (1917), Ann. Mag. N. H., Vol. 19, Ser. VIII, No. 110, p. 198, gives the locality of the type specimens as United Provinces, Khairabanda, Khasi Forest, 29, XI. 1913 (*C. F. C. Beeson*). Khairabanda forest is in Jalpaiguri Division, Bengal, not U. P.—C. F. C. B.

Phæomerus sundewalli, Boh.

Shothole borer.—*Butea frondosa, Dalbergia Sissoo, Heritiera Fomes, Shorea robusta.*

Distribution.—Siwaliks, U. P.; Jalpaiguri, Buxa, Sunderbans, Bengal, Tista, Goalpara, Assam; Kanara, Khandesh, Bombay, Karen Hills, Bhamo, Burma.

Protocerius grandis, Guer.

Stem borer.—*Phœnix paludosa.*

Distribution.—Pegu, Burma.

Rhyncholus himalayensis, Steb.

Shothole borer.—*Cedrus Deodara, Picea Morinda, Pinus excelsa.*

Distribution.—[Punjab and U. P. Himalayas.]

Rhynchophorus ferrugineus, Oliv.

Wood borer.—*Cocos nucifera, Phœnix dactylifera, Phœnix sylvestris.*

Distribution.—[India; Burma; Ceylon.]

Sipalus hypocrita, Boh.

Wood borer.—*Æsculus punduana, Bombax malabaricum, Dalbergia cultrata, Pinus Khasya, Pterocarpus dalbergioides.*

Distribution.—[India; Burma.]

Sympiezomias cretaceus, Fst.

Defoliator.—*Coffea arabica, Morus* sp.

Distribution.—[Madras.]

Stelorrhinus carinirostris, Mshl.

Defoliator.—*Tectona grandis.*

Distribution.—[Assam; Tharrawaddy, Burma.]

Trigonocolus brachmanæ, Fst.[38]

Shoot borer and girdler.—*Butea frondosa, Ougeinia dalbergioides, Pterocarpus dalbergioides.*

Distribution.—Andamans ; Bhamo, Toungoo, Thagata, Palon, Karen Hills, Burma ; Siwaliks, U. P.

Xylinophorus pencillatus, Mshl.

Leaf roller.—*Desmodium* sp.

Shoot girdler.—*Gardenia turgida.*

Distribution.—[Simla, Punjab, Jaunsar, Garhwal, Kumaon, U. P.]

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Barlow, E., 1899, Ind. Mus. Notes, IV.—*Notes on Pests from the Entomological Section*, p. 184.

Fletcher, T. B., 1917. B.—*Report of the Proceedings of the 2nd Entomological Meetings*, February 1917.

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[38] This insect is referred to by Stebbing, 1914, p. 425 et seq. as *Trigonocolus subfasciatus*, Fst., "the Andamans Padauk weevil." As the specimens in the Research Institute collected by Mr. B. B. Osmaston in the Andamans were evidently not *bifasciatus*, I sent them to Dr. G. K. Marshall for opinion. He informs me (27th January 1916) that the specimens are all of one species, namely, *T. brachmanæ*, Fst. The food plants and distribution of the insect appear to be extensive and I propose to drop the name "Andamans Padauk weevil" as unsuitable. The following references in Indian Forest Insects must be included in the synonymy of *brachmanæ*, Fst.

Trigonocolus subfasciatus, Stebbing (nec Faust), 1914, Ind. For. Ins., pp. 425—427, fig. 287, pl. XXX XXXV.—C. F. C. B.

STOCK-MAPPING FROM THE AIR.

BY J. N. OLIPHANT, I. F.S.

The commercial development of the Forest Department is most seriously retarded by the lack of proper stock maps of forest containing species of timber hitherto little exploited; many of these species are of considerable potential value. Manufacturers often enquire in what quantity the timber of a particular species, which they have found useful on an experimental scale, can be regularly supplied, and we are unprovided with even the roughest data on which to reply. Obviously, it is up to the Department to carry out a detailed survey of its resources in the least possible time. With existing methods of stock mapping the time occupied would be unconscionable, but it would seem that the work could be accomplished comparatively rapidly by aerial photography. I think it would be found possible by the use of suitable colour-filters and colour-sensitive plates, and by taking photographs at different seasons of the year, to differentiate many species by their foliage. Having located the species with reference to topographical features, the collection by a ground survey of data not obtainable from the aerial photographs should be fairly simple and expeditious.

The Home military authorities should be able immediately to place experts in aerial photography, and apparatus, at the disposal of the Department if the wheels were set in motion promptly. This is perhaps too much to hope for in India, but if the present opportunity is let slide the development of an aerial survey branch is

likely to be slow That the method suggested is bound to be adopted in the process of time I personally do not doubt; at all events, no one can now dismiss the idea as fantastic as might have been done a few years ago

The Department has lost immense opportunities during the war of developing the use of hitherto valueless timbers, simply and solely owing to inadequate provision for survey of its resources and for preparation of working-plans; and even now the need for such provision as an essential preliminary to commercial expansion seems to be inadequately realized. To make up for lost ground short cuts are needed, and the short cut above suggested should at least be made the subject of experiment as soon as practicable.

[The use of aeroplanes for observation work, chiefly in regard to fire-protection, appears to have been initiated in Canada. The idea above outlined has obvious possibilities and military aeroplanes and observation balloons could usefully be employed in peace time for work of this nature —HON ED.]

KING-EMPEROR'S BIRTHDAY HONOURS' LIST, 1919.

We are glad to see that the following members of the Forest Department figure in the recent Honours' List.

COMPANION OF THE INDIAN EMPIRE.

Henry Haselfoot Haines, Esq, Conservator of Forests, Bihar and Orissa.

Robert Selby Hole, Esq., Imperial Forest Botanist, Dehra Dun, United Provinces.

OFFICERS OF THE BRITISH EMPIRE.

Frederick Francis Ralph Channer, Esq., Deputy Conservator of Forests, United Provinces.

Adam Wilson Moodie, Esq, Deputy Conservator of Forests, Katha Divison, Burma.

MEMBER OF THE BRITISH EMPIRE.

John Ninian Oliphant, Esq, Deputy Conservator of Forests, Lakhimpur, United Provinces.

RAI BAHADUR.

Rai Sahib Nand Mal, Extra Deputy Conservator of Forests, Provincial Service, United Provinces of Agra and Oudh.

EXTRACTS.

A NOTE ON SOME OF THE SHIPBUILDING WOODS OF BURMA.

BY J. D. HAMILTON, PROVINCIAL FOREST SERVICE

1. As the question of shipbuilding is receiving something more than passing attention in Burma, a ten years' experience with some of the shipbuilding woods of the Province may be of use to those interested in the subject. It is a mistake to think that having so fine a wood as Burma teak other woods may be ignored. Teak is not the best wood which can be used in all parts of a ship and its use should be confined to the parts for which it is best suited. A judicious selection of woods would not only make for greater strength, elasticity and sea worthy qualities but would materially reduce the cost of the vessel.

In what follows I mention only such woods as I have used myself or have had under my own observation. There may be many other woods deserving of attention and perhaps those acquainted with their qualities will oblige us with the information.

The weights of the woods and values of P are taken from Gamble's "Manual of Indian Timbers."

WOODS BEST SUITED TO THE VARIOUS PARTS OF A SHIP

Keel.

2. *Bassia longifolia* —Bur. *Mèzè*, *Talainggaung* (Sandoway district —This wood is much prized in the Sandoway district for ships' keels. It is obtainable in 50 to 60 feet lengths of 2 feet siding. The weight of the seasoned timber is about 60 lb. to the

cubic foot and the value of P about 720. Add to this that it seasons well, is very durable and is not attacked by teredo and we have all the ideal qualities for a keel

All works on the forest flora of Burma mention this tree as only found cultivated in the province, but the tree is certainly indigenous to the Sandoway and Kyaukpyu districts. Botanical specimens taken by me in 1910 were scientifically examined at Calcutta and confirmed as *Bassia longifolia*. It was said not to have been recorded from Burma before, but the Burma Forest Act has it as one of the reserved trees of the province. This, one concludes, was some form of intelligent anticipation.

Artocarpus Lakoocha—Bur. *Myauklok* (Sandoway, *Myauk-gaung*) Weight 40 lb. to cubic foot. P = 475 Though this timber has not the weight and strength of *B. longifolia* it is also immune from teredo. It is used for the keels of sea-going vessels built at Gwagyaung in the Sandoway district and has a very good reputation. It yields keels 50 to 60 feet long.

Hopea odorata—Bur. *Thingan* —Weight 50 lb. to cubic foot. P = 800. This wood behaves extremely well in both salt and fresh water, but it is not immune from teredo. It yields squares 50 to 60 feet long with 24 inch siding. It seasons well and is an exceptionally strong and elastic wood and is admirably adapted for the keels of ships. Large quantities of this timber are available in the Moulmein, Tavoy and Mergui districts, and a fair amount is found in Arakan.

Lagerstrœmia Flos-Reginæ—Bur. *Pyinma* (Arakan, *Kam-aung*).—Weight 40 to 45 lb. to the cubic foot. P = 750. In suitable localities the tree yields 18 inch squares 50 feet long. It seasons well and, though somewhat lighter than teak, has a much higher value for P. It behaves well in both fresh and salt-water and is only sparingly attacked by teredo. I once cut the keel and planking of a wrecked brig and found the timber to be quite sound. The vessel had been in the coasting trade for over twenty years

Xylia dolabriformis—Bur. *Pyin* or *Pyinkado*.—Weight when dry 60 lb. to the cubic foot. P = 1,000. Logs 60 feet long with

20 inch siding are procurable in most of the better forests. I have but once seen this wood used for the keel of a small brig and on one occasion I used it myself for the keel of a sea going motor boat. Its weight and strength are very much in its favour. It also seasons remarkably well and alters very little with climatic changes. It has two disadvantages. It is loved of the teredo and is so hard that holes have to be bored to almost the size and depth of the nail or screw used. Screws often break off rather than penetrate ¾ inch of unbored wood. Heavy nails which have gone in to about an inch of the head turn over if meeting unbored wood, and it is equally exasperating to find that nails once so lodged are impossible to extract. Sometimes, too, the hardness of the wood varies in the same scantling, and nails or screws of a given size will not go home in all borings of the same size and depth. Unless this is detected before the nail turns or screw breaks there is bound to be trouble. And if you are using Chinamen they want to down tools and twang like banjos out of tune.

The wood contains much tannin and may attack iron as oak does. But oak is reckoned one of the best shipbuilding timbers in the world.

Stem and Stern Posts.

3. The same woods as have been mentioned for the keel are suitable for stems and sterns. They all yield natural crooks.

Timbers (bent).

4. These would be used only in small-sized craft such as ships, boats and launches. I have found *Saga* (Michelia Champaca) a most excellent wood for the purpose. It is light in weight, tough, seasons well and the value of P is probably about 600. It is very durable in both fresh and salt-water

Pyinma (Lagerstrœmia Flos-Reginæ) is almost as good as *Saga*. But great care should be taken in selecting this timber as there are at times curious breaks in the continuity of the fibres which make it impossible to bend the timbers without damage. Both *Saga* and *Pyinma* receive nails well without splitting. These woods should be soaked in water for twenty-four hours before steaming if very dry.

5. Natural crooks and bends are of course best and nothing else would be used in first class construction.

Timbers (cut).

Pyinma (L. Flos-Reginæ) probably yields the best crooks among all the Burma woods. The natural tendency of its larger limbs to grow crooked, its high value for P, and its excellent behaviour both in fresh and salt-water leave little to be desired.

Thousands of crooks are cut every year in Arakan for use in local craft and for building brigs at Chittagong. As often as not the builders do not trouble to remove even the sap, yet they last remarkably long.

Other woods which yield good crooks are teak (Tectona grandis) when on poor soil, *Saga* (M. Champaca), *Thingan* (Hopea odorata), *Padauk* (Pterocarpus macrocarpus), *Ponnyet* (Calophyllum Inophyllum) and of course *Pyinkado* (Xylia dolabriformis). The last yields an infinite variety of excellent crooks of phenomenal strength and elasticity. But then there is the nail trouble mentioned before. Some day the difficulty will be overcome and we shall then have for use a stock of the finest crooks, bends and knees in the world. But as a caution I might mention that on the southern shores of Sandoway there is a roving lunatic who, the boat-builders at Gwagyaung say, went off his head when only half way through with a cargo boat in which he had placed *pyinkado* ribs.

Deadwoods

6. *Thingan* (H. odorata), *Pyinma* (L. Flos-Reginæ), *Talaing-gaung* (B. longifolia), Teak, *Pinlèkanazo* (H. Fomes), *Padauk* (P. macrocarpus).

Gunwales, Inwales, Shelfs, Stringers.

7. *Thingan*, *Padauk*, Teak, *Kashit* (Pentace burmanica), *Saga* and *Pyinma*.

Deck Beams and Carlines

8. *Thingan*, *Pyinma*, Teak, *Pinlè-kanazo* *Padauk*, *Saga* and *Kashit*.

Planking.

9. Teak is the finest all-round wood for the purpose. Its sterling qualities are known the world over. Lloyds give the most favourable terms for vessels planked with teak and it is as well to reckon with them if the vessel is intended to be insured. The further great advantage

of dealing with teak in Burma is that, owing to precautions taken by the Forest Department, nothing but seasoned timber ever gets on the market. Moreover, from the large quantities available perfect planks of almost any requisite length can be obtained. One cannot go wrong in using first class Burma teak. It is unfortunate that it is not quite immune from teredo and that it is so very expensive, but it would not be so good at a lower price. In buying selected teak planking one procures the finest and best seasoned wood in the world.

Pynma (Lagerstrœmia Flos-Reginæ).—If this wood is carefully selected it makes very excellent planking indeed. It is very durable in both fresh and salt-water and is less attacked by teredo than teak. In Arakan and Chittagong they use nothing but *Pyinma Kamaung* or *Farul* in planks anything up to three inches thick. I have seen vessels with sound planking which have had the roughest of rough use for twenty years—six months in the water and six months on the hard. I do not know how the timber acts in contact with iron, but it contains nothing obviously inimical to this metal, and in parts where it has been in use for ages one hears of no ill report. Many forests in Burma yield very fine *Pyinma* logs. The tree favours the rich valleys in the hilly parts of Lower Burma and Arakan and this makes extraction fairly easy compared with many other woods. The timber seasons well when girdled, but the planks should be carefully selected as there are at times flaws in the wood owing to fibres not anastomosing in the usual way. Logs with heavy burrs are not suited for planking though they yield very handsome panelling.

Artocarpus Lakoocha—Bur. *Myauklôk* (Sandoway, *Myaukgaung*).—This is another good wood for planking. It is freer from flaws than most woods and is said not to be attacked by the teredo borer. It seasons well but is unfortunately not very common. The tree attains a very large girth and a single log is capable of yielding a large number of sound planks. The timber is largely used in parts of Arakan.

Hopea odorata—Bur. *Thingan.*—This is a most excellent wood for planking. It is tougher and stronger than teak and very

durable both in fresh and salt-water I have always found it to be of very even quality, to season easily, and to vary very little with climatic changes. It is not immune from teredo but suffers no more than, if as much as, teak.

Pentace burmanica—*Bur. Kashit* or *Thitka.*—Weight 40 lb to the cubic foot. P = about 600. It is about as hard as teak. This is a beautiful wood for ships' boats and launches. I once used it for planking a motor launch and was very pleased with the results. After five years of rough usage in fresh and salt-water and in the mud of mangrove the creeks the wood showed as fresh and as sound as on the first day. There were a few pin-holes from teredo attack which showed that the timber was not immune from this pest.

Kashit logs are of very even quality and often of considerable size. I have seen logs over sixty feet long and ten feet in girth in the Sandoway district. The tree is fairly plentiful on the higher levels throughout Lower Burma. It seasons well when girdled and is not much affected by atmospheric changes. It is suitable for sawing into thin planks for what is known as the multiple-skin construction of the hull and was used by me in this form.

Michelia Champaca—Bur. *Saga* or *Taungsaga*.—Weight about 37 lb. per cubic foot. P for Mysore wood is quoted by Gamble as 642 and for Nepal wood as 561. No experiments appear to have been performed with wood from Burma. Taking the value of P for teak as 575, I certainly think that for *Saga* would be as much if not more. It makes excellent planking for boats and launches and is very durable in both salt and fresh-water. I have seen it used for sea-going cargo boats in Arakan, and it has the reputation of being very little affected by teredo. The tree belongs to the moister and higher levels. It is not common but attains a very large size. There are very few defects in the wood and almost every log yields a very high percentage of beautifully even planks. The timber may be sawn into planks green and then allowed to season in the shade. In about a year or 18 months the planks will be found to vary very little when put in place. *Saga* is a handsome wood and not unlike teak in appearance.

Artocarpus Chaplasha—Bur. *Taungpeinnè.*—Weight about 40 lb. to a cubic foot. The quality of this timber varies very much with the soil. Where it grows with a straight clean fibre it is a very fine planking wood and has great lasting qualities in both fresh and salt-water. The tree grows to a great size and seasons well. I have only seen the planking used for small sea-going craft. It makes excellent planking for boats and launches, and works and finishes in a very pleasing manner.

Before leaving the question of planking, I would venture to offer a suggestion to guard against teredo since copper sheeting has become little more than a memory of former times. I once came across an observation in an American journal that teredo did not pass out from one piece of wood to another even when closely in contact. I accordingly took to examining the piers and bridges in the Sandoway and Kyaukpyu districts, and repeatedly found that teredo which had got into the struts never passed into the posts, though it had eaten the struts to wafer thinness where in contact with the posts. In the multiple-skin boats I built, the teredo pin-holes in the outer layer never passed into the inner planking. I am accordingly inclined to believe that teredo will not pass out from one plank to another even if in close contact. If therefore a ship's planking were to be overlaid with another layer of, say, one inch planks below the load water line, much, if not total, immunity would be secured for the true hull of the ship. To add further to this security I would suggest the protecting wood be of a species known to resist teredo. Of all such woods Fagræa fragrans, Bur *Anan*, stands first. At Tavoy there are posts which have stood in water from two to three hundred years unattacked by teredo. The weight of the wood is about 60 lb. to the cubic foot, and the value of P is *probably* about 550—though it needs to be redetermined as it seems too low and some experiments have shown as much as 980. Large quantities of *Anan* can be obtained from the forests between Moulmein and Tavoy. When putting on the outer skin, the opportunity could also be taken to place a layer of heavy pitch-soaked sacking or other such material underneath this skin and so render the vessel

all the more water-tight. If this second skin is laid diagonally to the first it also adds enormously to the strength of the hull.

Deck

10. The woods mentioned for planking are all suitable for this purpose, and I would add *Padauk* (P. macrocarpus) where a light-coloured deck is not a *sine quâ non.*

Coamings.

11. Teak, *Thingan*, *Padauk*, *Pinlèkanazo*.

Covering boards.

12. For small craft, ditto.

Thwarts and seats

13. Teak, *Kashit*, *Thingan*, *Taungpeinnè*, *Padauk*, *Pyinma*, *Saga*.

Bulk-heads.

14. Much depends on the nature of the bulk-head required. If it is also intended to stiffen the ship or likely to be subjected to rough usage in handling cargo, *Thingan*, *Pinlèkanazo*, Teak, *Pyinma* and *Padauk* are suitable woods. For lighter purposes and mere partitions, *Kashit*, *Saga*, *Taungpeinnè*, and even *Thitkado* (Cedrela Toona) could be used with advantage.

Flooring.

15. The woods suitable for decking are also suitable for flooring, though it is customary to use a lighter wood for flooring where heavy cargoes are not concerned. In such cases *Pyinma*, *Saga*, and *Kashit* could be used with advantage.

Floors or floorbearers.

16. These are best made of a tough elastic wood—*Pinlèkanazo*, *Thingan*, *Pyinma*, answer the purpose perfectly.

Rudder.

17. Rudders on large vessels are usually of metal. But if wood must be used metal should not be stinted to stiffen the structure. It is impossible to get wood with the fibres running to suit all the strains to which a rudder is subjected. In the Sandoway district and other parts of Arakan where metal is not easily procurable, rudders are often cut in a single piece from the great buttresses given off by *Thitpok* (Tetrameles nudiflora) and for smaller craft from similar growths found on *Pinlèôn* or sea-cocoanut (Carapa obovata). The latter is a very strong, heavy, and durable wood,

but the former is light and perishable and needs constant renewal. These makeshifts for the more primitive types of craft show how difficult it is to make strong rudders without the liberal use of metal.

The woods suitable for built up rudders are—*Pyinkado*, *Thingan*, *Pinlèkanazo*, *Padauk*, *Talainggaung* and *Pyinma*. For the rudder post any of the first four and for the steering wheel *Padauk*, Teak, *Thingan*, or *Pinlèkanazo*.

Masts

18. There always seem to the difficulties in procuring good masts, and yet Burma contains most excellent woods for the purpose. For large vessels I place them in order of importance:

Thingan (Hopea odorata), *Pinlèkanazo* or *Yezo* (Heritiera), *Pyinkado*, *Talanggaung* (Bassia longifolia), *Teak*, *Tharapi* (Calophyllum spectabile), *Pyinma*. I have seen every one of these woods in use and they answer their purpose perfectly. The idea of *pyinkado* for masts may strike one as rather unusual. The name of iron-wood, its extreme hardness and green weight all lead one to suppose that it is inordinately heavy for the purpose. And yet its weight when dry is about 60 lb. to the cubic foot whereas *Pinlèkanazo*, which is often used for masts, averages 67 lb. to the cubic foot. Seasoned *Pyinkado* from rich soil where its growth has been quick is often not more than 55 lb. per cubic foot and I have seen it floated out in the Sandoway river in rafts like teak. I have seen similar light *Pyinkado* which had been killed in *taungyas* (hillside clearings) at the head-waters of the Môn and Kyaukkyi streams in the Shwegyin district. As the behaviour of teak is so well known I give comparative figures indicating what may be expected from a *Pyinkado* mast of the kind mentioned.

Teak lb. per cubic foot 45—50, P=575. E=3,600.

Pyinkado lb. per cubic foot 50—55, P=1,000. E=4,150.

This shows the enormous strength and elasticity of a *Pyinkado* mast. For small vessels requiring light and elastic masts *Pyinma*, *Tharapi* and *Thitmin* (Podocarpus neriifolia) are suitable.

Cabins and cabin fittings.

19. Woods light in weight and of handsome grain are naturally desired. But they must at the same time be woods which vary little with

climatic changes and last long. Burma has a long list of such woods. I here only mention a few which I know can be used with every confidence.

Kashit (Pentace burmanica). Light red. Not unlike mahogany.

Thitkado (Cedrela Toona).--Known as "Moulmein Cedar" on the English market

Saga (Michelia Champaca).—Light olive brown. Very handsome. Somewhat resembles teak.

Taungpeinnè (Artocarpus Chaplasha). -Yellow to brown. Gives a very pleasing effect with *Kashit* or *Thitkado.*

Thitmin (Podocarpus neriifolia).—Yellow or yellowish grey. Takes a beautiful polish.

Pyinma (L. Flos Reginæ).—Reddish. Logs with burrs produce a very handsome grain.

Yemanè (Gmelina arborea) —*Yellowish or greyish. Takes a* very fine polish and can be stained to any colour.

Maniawga (Carallia lucida).—Red with beautiful silver grain. Makes very handsome panelling. Somewhat heavier than above woods and about the same weight as teak.

20. In the table of woods given below the values are quoted largely from Mr. C. G. Rogers' work on "Forest Engineering," Volume I, and Mr. Gamble's "Manual of Indian Timbers."

In the former work the formula for obtaining P, or the *coefficient of transverse strength,* is given as—

$$P = \frac{W \times L}{b \times d^2}$$

where P is expressed in pounds Avoirdupois.

W = the breaking weight, or the weight in lb. which, when placed on the middle of the bar, causes it to break.

L = the length of the bar between supports *in feet.*

b = the breadth of the bar *in inches*

d = the thickness of the bar *in inches.*

ty E_d is obtained from the formula—

$$E_d = \frac{L^3}{bd} \times \frac{W}{\text{[illegible]}}$$

where L = the clear distance between the supports *in feet.*

b = the breadth of the beam *in inches.*

d = depth of the beam *in inches.*

W = weight supported at the centre of the beam in lb.

x = the maximum deflection of the beam *in inches* without causing appreciable permanent distortion.

To the table have also been added a few woods largely used in Europe for shipbuilding to enable those familiar with their use to get a more practical idea of our Burma woods.

Burmese name.	Botanical name.	lb. per cubic foot.	Value of P.	Value of E_d.	Crushing weight.	Purpose for which best suited.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Anan	Fagræa fragrans ...	60	550	..	9,200	See planking.
Kashit or Thitka ...	Pentace burmanica ..	40	570	..	..	Planking and cabins.
Kyun (Teak)	Tectona grandis ...	45— 50	575	3,600	15,482	Planking and decks.
Maniawga	Caralla lucida ...	46	700	...	...	Panelling cabins.
Myaukkyauk or Myaukgaung	Artocarpus Lakoocha ..	40	475	-	..	Keels, and planking.
Padauk ...	Pterocarpus macrocarpus .	60	800	4,180	19,036	Deck and flooring.
Pinlekanazo or Yezo ...	Heritiera Fomes ..	64	900	3,726	29,112	Masts and floors.
Pyinkado	Xylia dolabriformis .	60	1,000	4,150	16,657	Masts and rudders.
Pyinma	Lagerstrœmia Flos-Reginæ	40— 45	750	3,665	15,388	Planking, decks, masts, timbers
Saga .	Michelia Champaca .	37	560	3,360		Planking timbers.
Talainggaung or Mèzè ...	Bassia longifolia ...	60	720	.		Keels, stems, sterns.
Taungpeinnè	Artocarpus Chaplasha .	35	460	.		Planking and cabin.
Tharapi	Calophyllum spectabile .	39	530	.		Masts.
Thingan ...	Hopea odorata .	50	800	3,660	22,209	Keel, planking, decks, masts.
Thitkado	Cedrela Toona ...	33	465	3,126	9,000	Panelling, lockers.
Thitmin	Podocarpus neriifolia ...	40	588	...	...	Masts, cabins.
Yemanè	Gmelina arborea ...	36	375	2,132	...	Cabins and furniture.
	Woods used in Europe.					
Oak	Quercus pedunculata	58	560	3,925	6,400	Timbers, planking.
Larch	Larix europæa ..	37	629	3,700	.	Planking.
Mahogany ..	Cuba	48	642	..	..	Planking small craft, cabins and furniture.
	Honduras	41	601	.		
	Mexican	42	587		...	

21. In procuring timber for shipbuilding the greatest care should be taken to see that no mistake is made about the kind of wood supplied. It is not easy, even after considerable familarity, to say with certainty that a particular wood is really what it purports to be. The only safe method is to compare the wood with Gamble's description and *at the same time with a known sample of the wood.* In case of uncertainty it would always be advisable to get the opinion of a forest officer who had studied the subject. It is not always safe to depend on the local carpenter or other such timber expert. I have known them make some very bad mistakes. Ships are expensive to build, so I shall mention two cases in which the wrong timber was supplied, and accepted, to show how easy it is to go wrong.

The Forest Department once recommended *Anan* (Fagræa fragrans) to the Public Works Department for bridge piles knowing the timber to have stood the test for two or three hundred years. The Public Works Department were supplied by a contractor with a wood which perished in a couple of years. They were naturally very angry with the Forest Department. On enquiry it was determined that the wood the Public Works Department got was not *Anan* Fagræa fragrans) but *Ananbo* (Crypteronia pubescens), the timber contractor explaining that he thought one kind of *Anan* was as good as another.

At Sandoway I found a contractor had been supplying the Assam-Bengal Railway with three kinds of *Pyinkado* sleepers—Black, White and Red The Black was *Taukkyan* (Terminalia tomentosa), the White—*Yon* (Anogeissus acuminata), the Red—*Phabye* (Eugenia *spp.*). There was never any real *Pyinkado* (*Xylia dolabriformis*). What actually happened in Assam or Bengal I do not know, but when the Forest Department some years later undertook the supply of sleepers the Railway were very insistent with their demand that every sleeper should bear a Forest Department hammer mark as a guarantee that the wood was *Pyinkado*. The former colour scheme (Black, White and Red) had evidently not come up to expectations.

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OBSERVATIONS ON SOME EFFECTS OF FIRES IN THE CHIR (*PINUS LONGIFOLIA*) FORESTS OF THE WEST ALMORA DIVISION.

BY H. G. CHAMPION, I.F.S.

The writer of these notes was posted to the W. Almora Division just in time for the whole of the disastrous fire-season of 1916, when the greater part of the time of the D. F. O. and all the three attached gazetted officers had to be given up to rushing from fire to fire, in efforts to save at least something from the general conflagration. This season of 1916 is so well known to all who were in the hills at the time, and is so unlikely to be forgotten by them, that nothing more need be written here beyond remarking that an exceptionally dry state of the forests (following the failure of the winter rains) and an outburst of incendiarism, combined to create the worst record since fire-protection was introduced. A climax was reached on May 24th 25th when large fires were raging all at once in the old reserves of Binsar and Airadeo which had been under fire-protection for many years, in Akwabinsar, a new reserve with resin-tapping, and in Pandrapali, a

felling area ; that in Airadeo continued three days and two nights, new fires being started time after time directly a counterfiring line was successfully completed.

Since then, nearly three years have elapsed and there have been abundant opportunities for noting the immediate and deferred results of these fires, and a number of miscellaneous observations (largely from Katalekh where fires occurred in the first week of May) are collected below, grouped, according to the size of the trees, as large, small, or in the seedling condition, followed by some few notes on the effects on the forest vegetation apart from the chir itself.

I. Large Trees.—One of the chief lessons to be drawn from these fires is that even the largest trees cannot withstand a bad fire when conditions are against them. W. Almora was fortunate in escaping the complete destruction of the tree-growth over large areas such as is understood to have taken place in the Gaula Valley in Naini Tal Division, the more usual effect being that of a heavy thinning removing on the whole the less vigorous trees, or narrow strips where the configuration of the ground is such that the fire-created wind swept up as through a funnel. In two reserves, however, Katalekh and Pandrapali, clear fellings over fairly large areas have been necessitated by the death of practically the whole stand ; both are on rather hot southern exposures with heavy grass, the damage being in the upper parts and the trees on the ridges having sometimes survived when those in the dry water-courses have been killed. In both areas trees up to six feet and more in girth were killed outright ; and although the resin channels in Katalekh must have been a factor of importance, there were none in Pandrapali where these large trees perished, even in sections quite free from felling débris which unfortunately littered other parts.

A noticeable feature of this destruction of the mature crop was the gradual way in which it took place. Inspection of the burnt areas in the months immediately succeeding the fires gave one the impression that the forests would after all escape with simply a heavy thinning ; but since then, in the worst affected areas,

more and more trees have died each month, much as they sometimes do round a lightning-struck tree. Pandrapali provided a very striking example of this : the writer marked over this block in the cold weather of 1916-17 for conversion to the Uniform system, and, on inspection a year later, it was found that many of the trees selected as seed-bearers on account of their good quality and apparent vigour, had since succumbed, and notably one fine tree 8 feet in girth and with a clean bole of some 60 feet to 70 feet, which had appeared to have been hardly touched by the fire as it was growing on an old field free from grass and débris. In Katalekh fellings of dead trees were carried out soon after the fire, but fresh trees have gradually died since, necessitating two further markings ; and even now, in 1919, trees which have retained green and seemingly healthy, if restricted, crowns, will suddenly turn colour and dry up in the most seriously affected areas. In Khabdoli South C. 10, six maturing trees which had been injured by fire on May 8th, 1916, were selected on 3rd March 1917 for observing the effects of the loss of varying proportion of their crowns ; on a first inspection on 13th June 1917, one tree had only one green shoot left out of an original twelve, whereas the others were 'much as before ; and on 18th June 1918, all were found to be dead, although the less injured had still had 25 to 30 healthy shoots at the time of selection.

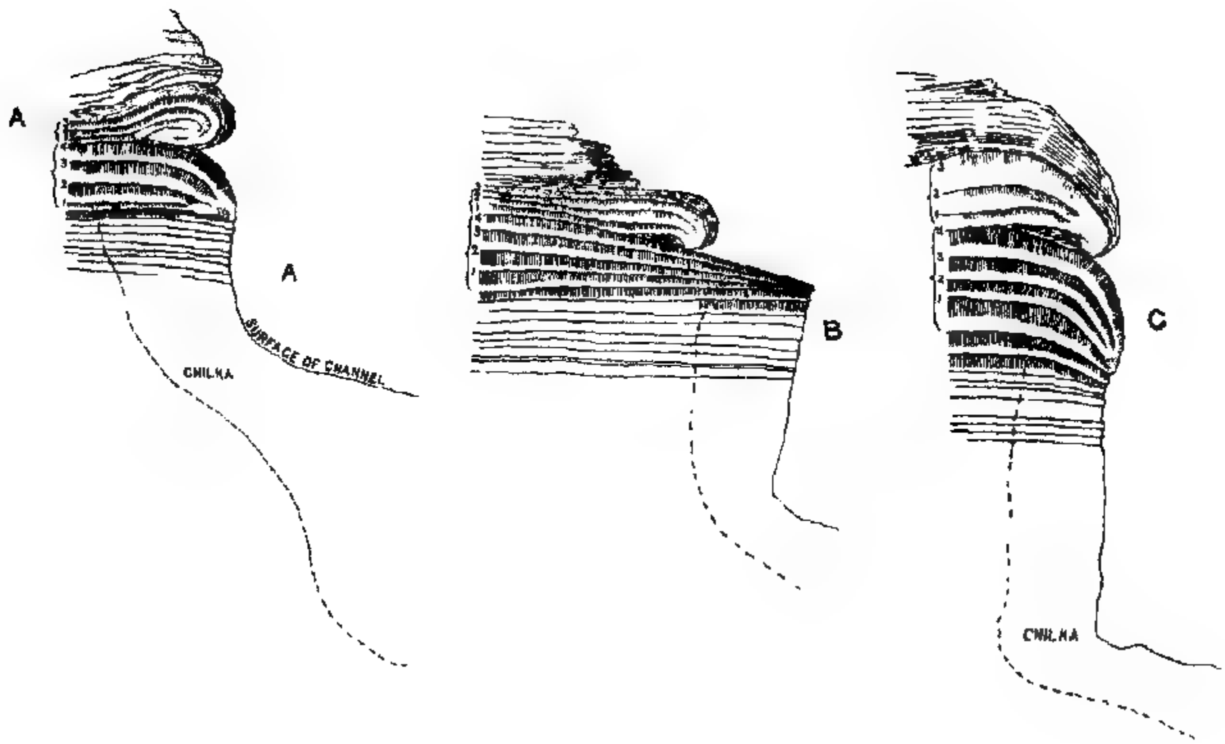
As these trees, which died in years subsequent to that of the fires, were not as a rule visibly injured to any unusual extent at the base and, instead of gradually dying back, frequently turned colour suddenly and dried up (preceded by the death of the cambium in the bole), it becomes a very difficult matter to tell, even after careful inspection soon after the fire, what the extent of the damage will be, and one is left to speculate as to what the actual mechanism is that causes this deferred dying off. It would appear that from some cause or other the gradual death of the cambium results, and when this has circumscribed the trunk the whole tree dies.

Serious infestations of bark and shot-hole borers were anticipated as a result of the tremendous amount of dead and dying

timber throughout the district, but fortunately these fears did not materialize. At the invitation of the D. F. O., a special examination of the Katalekh area was made in October 1917, and the result was the conclusion that the insects were not even numerous enough to make full use of the material available for them so that dead and dying trees practically free from insects could be found. *Ips longifolius* was hardly seen and although *Polygraphus* sp. was abundant, there seemed to be plenty of Histerid predators, etc., to keep it in check. *Platypus biformis* is more troublesome as it greatly depreciates the value of the timber subsequently sawn from the fire-killed trees ; it is also not infrequently the first insect to attack freshly killed standing trees, but as far as my observations go can never be considered a primary cause of death. An interesting example of what happens when this insect tries to attack a living tree was found in several badly scorched, but still quite vigorous, trees in Katalekh which were felled for stem analysis. Resinous pitch tubes were noticed on the bark and, on careful examination, were found to contain dead Platypus; whilst beneath, the only effect had been the formation in the wood of a small resin pocket about ¼ inch square. This insect is sometimes extraordinarily abundant, and one may find areas of bark with one or more insects to every square inch of surface.

One other insect common in the fire-killed trees is a *Cryptorrynchus* (? *C. brandisi*) which may be found in trees before the crown has turned colour, and that sometimes right up to the limit of visibly dead cambium, but of this species also I doubt if it is ever the primary cause of death.

Leaving the case of the trees actually killed, one has to consider the effects of the fires on the trees which survive. Despite what has been said above, the powers of resistance of chir to fire might well be proverbial: one can find trees hacked for torchwood by the villagers, with the base of the bole reduced to a semi-circular strip some 6 inches thick (and even the bark on that hacked through in many places, and partly dead and insect-infested), which will stand being set on fire annually in the early hot weather : one can find trees charred up to a height of 50 feet and 60 feet and still



EXPLANATION OF PLATE.

Resin channels which have been made in 1911 and burnt in 1916; sections cut in 1919, to shew effects of fire on callus formation.

All are drawings to scale, * 2, of one side of the channel.

A.—No. 101. Tree 96 years old, girth 4': slight injury seems to have occurred to the side of the old channel, but not sufficient to prevent callus formation right up to the edge: first callus killed back ⅜"; channel now about ¼" on each side wider than originally.

B.—No. 97. Tree 94 years old, girth 3'9": first callus thin but continued right up to the edge of the channel, killed back 1": channel now over ½" wider on each side than originally.

C.—No. 97, same tree as B but opposite side of channel: first callus normal, killed back over 1": channel now approximately same width as 7 years ago.

* The point to which the merismatic tissue has been killed back.

... The dotted line shows the limit to which the wood has become impregnated with resin and termed locally "chilka."

apparently little the worse for it: one can find trees which have had burning logs lodged up against them, perhaps for a week or more, and though charred half way through at the base, merely direct a copious deposition of resin in the wood around the wound, but appear otherwise unaffected. In spite of this, it is difficult to believe that the tree can really put up with all this without, as it were, taking some notice and so a look-out has been kept to see in what way, if any, it does respond to the shock.

Recently a number of careful stem analyses have been made in the burnt areas and adjoining unburnt ones. It was thought that the increment as indicated by the spacing of the annual rings might show differences, and this was borne out in several cases where the charred trees showed a sudden drop in the width of the rings of growth subsequent to 1916. The average of measurements on the 5 feet section of five unburnt trees gave a radius increment of ·05 inch each for 1917 and 1918, whilst five trees with considerably charred bark showed only about half this, the increment being ·025 to ·02 inch. (These trees were all under 4 feet girth and were not being tapped for resin). It was found, however, that this difference is only noticeable at the base of the tree, and although sometimes apparent at 15 feet and even 25 feet from the ground, it is more usually hardly appreciable at 15 feet and no trace persists at the top in the crown. It can be shown that if the effect be assumed to extend to one-third of the height, then only about 80 per cent. of the normal increment is put on in these first two years after the fire. For the crop in question, supposing the effect to be halved annually after the first two years, this diminution will in all amount to a loss of 70 c. ft. per acre.

Since an ever-increasing proportion of our chir forests is being brought under resin-tapping, it is important to investigate the effect of fires on the rate of closing up of the channels. It is unnecessary here to discuss the time taken for complete closure under normal conditions, and only the influence of firing on this rate need be considered. The callus tissue occluding the wound from the two sides of the blaze is thin-barked and resinous, and the blaze too is of course covered with resin, and even with a light

ground fire the channels always get burnt: the living tissues at the edges of the channel are killed, and the net effect is that the width to be healed for complete closure is increased. In the sections examined, it was found that it takes the tree three or four years gathering impetus so to speak and healing any dried out part of the cambium at the sides of the blaze, before it actually begins to diminish the width of the exposed wood. A fire coming at this stage will usually kill the embryonic tissue of the callus for a distance of about an inch along the curve which is equivalent to widening the blaze about ½" on each side. Expressing this differently, it may be said that if it takes 12 years normally to heal the 4" blaze, then it will, in the example quoted, take 15 years, and some 3 maunds of resin per acre may be lost in the long run: the material examined was scanty, but this is thought to be a low figure and it is likely that a greater width of new growing tissue may easily be devitalized. It may here be noted that in the basal sections of a tree under tapping all increment seems to be concentrated on healing up the blaze, and the opposite side of the trunk will commonly show very narrow annual rings—hence such trees have been excluded in dealing above with the effects of fire on radius increment.

Next we may examine the effects of fires on the production of cones and fertility of their seed. Unfortunately we have been having a run of bad seed years, so that deductions from the paucity of cones in the burnt areas are dangerous; however, one or two facts can be recorded and deductions made. At the time of the fires, the seed would be falling or have already fallen from the mature cones, and have been mostly burnt with the grass, etc., on the ground. The cones due to ripen in 1917 would be in their most actively growing stage and some at least of these are killed and dried up on the tree, but being high up in the crown the majority probably escape. The 1918 cones would be still quite small and protected by the green needles, but they must be very delicate and injuries due to the fires probably account for the relative frequency with which aborted cones of this crop were found on

the trees examined. Remembering that all three years were bad seed years in any case, the relative numbers of seedlings 1, 2 and 3 seasons old over the 200 acres examined in Katalekh would indicate that the seed of the 1916 crop was almost entirely destroyed on the ground, that a fair number of the 1917 crop survived and considerably less of the 1918 crop—but, as noted, these deductions are open to question.

A point which bears out previously recorded experience is that, in almost all cases, it is the upper side of the tree which suffers the greatest damage, even where the fire is sweeping uphill; the main causes are undoubtedly the accumulation of inflammable débris on the upper side, especially in felling areas, and to the upward swirling currents of air created by the obstruction offered by the trunk to the direct wind.

II. Smaller trees.—The case of smaller trees, from regeneration 5 feet or 6 feet high up to young poles 30 feet or so high, is rather different. Height, rather than girth increment, is here important and anything affecting the straight growth of the leader must be considered. The question as to the height at which chir regeneration can be considered as safe from fire, at least in the sense that a fire can be put through it under control without harm, is too open a one to take up here, though general observations indicate a figure in the neighbourhood of 15 feet to 20 feet under average local conditions. It stands to reason that fires which kill 6 feet trees make short work of small pole regeneration; in fact, it is only in these that one gets a real crown fire. Commonly a few survive even the worst fire, but being isolated they are useless and have to be removed; in an average fire, the effect is to kill all the weaker stems—which may not do much lasting harm.

As the height growth of young trees in any given year depends on a great number of factors, it is impossible to come to any definite conclusions without far more data than we have, but in Katalekh it can be noted that in trees which had been much scorched but had not succumbed to the 1916 fires, the growth in 1917 was, on the whole, below the average for unburnt areas, and that of 1918 was again about normal.

A noticeable feature was the frequency with which, though the tree survived, more or less injury to the leader has occurred. A decided tendency to droop was noticed in 1916 soon after the fires and this curvature is still visible in many examples from 5 feet to 15 feet high though it will doubtless disappear later on. Not rarely the leader itself has been killed, and its place been taken by one or more of the lateral shoots; the reason for this is not easy to give unless it also is due to the presumed cause of the droop, *i.e.*, shortage of water-supply consequent on shock or injury to the conducting tissues.

Injury by fire to quite small regeneration 2 feet to 6 feet high usually results in the death of the upper portions and the development of many latent buds, mostly at the points of branching and just above ground; the former often develop further, but I have not yet seen a plant over 2 feet high, killed almost to the ground which had been able to produce a coppice shoot vigorous enough to replace it, and small plants which have this power require the full light of a fire-line or similar locality to exhibit it.

III. Seedling Regeneration.—To deal next with seedling regeneration, we have to consider that which pre-existed the fire and that which follows it. I doubt if a one season old seedling ever survives a fire—certainly none did the 1916 fires—but it is probable that not a few two season old ones do, especially if they have developed the thick carroty base to the stem and hypocotyledonary region, and although the needle-bearing portion of the stem is killed, new buds develop and the plant survives. The same applies to the three and four season seedlings in increasing degree and it is undoubtedly this power combined with the smaller amount of grass, etc., that has led to the characteristic formation of often dense young pole crops round old cultivation and cattle-stations despite annual firing. However, in areas which have been fire-protected for any length of time, none of these small seedlings is likely to escape destruction—no survivors were found in Katalekh. A further typical example of this is from Khabdoli South C. 6, where two adjoining plots 20 ft sq., one on each side of the line on which the fire was stopped, were examined in

November 1916. The number of 1916 seedlings was practically identical in the two (22 and 24), but whilst the unburnt area had another 32 small plants from the previous years, only one coppice shoot could be found on the burnt plot.

Some rather interesting, if not altogether conclusive, data were collected in Katalekh as to the growth of seedlings from self-sown seed after the fires. It has already been noted above that seed has been very scanty, seedlings from 1916 being especially rare, but what few were seen are among the most vigorous natural seedlings I have yet found, running up to 15 inches in height, being already branched, and appearing full of life; it must be remarked, however, that such seedlings were nearly all in especially favourable spots. The growth, year by year, of 80 seedlings from the burnt area as compared with 100 from an adjoining unburnt forest is instructive, and after plotting on a curve and regularizing (which happens hardly to alter them), appears as follows :—

Number of seasons old ...	1	2	3	4	5	6
Average height in burnt area ...	4·2"	7·1"	9·5"	(11·8")		
Average height in unburnt area ..	4·0"	6·3"	7·8"	8·9"	10·3"	(12·0")

In other words, the seedlings in the burnt area will reach a height of 1 foot in four years, as compared with six years for the unburnt. Three possible reasons are suggested which could be tested if desired, *viz.* (i) mineral manuring of the soil by ashes of burnt grass, etc., (ii) diminished competition with coarse herbaceous vegetation, and (iii) increased light owing to the thinning of the crown cover above them. Any or all of these three may explain the figures given, but the writer is inclined to think that the first is not the least likely, although the small difference in the growth of the first season found in the Khabdoli plots mentioned, may be taken as militating against it.

The data given in the last paragraph refer to C. 5, which is an old regeneration area with a northerly aspect. On the opposite side of the ridge, however, in C. 12, where the whole stand was wiped out, it is hard to find a seedling at all, and sowings both here and in a similar locality in Pandrapali (though there the rock is

limestone and not mica schist) have only met with a very limited degree of success. On both sides the very humus itself was largely burnt out; but, on the south, the exposure to isolation emphasized by the sudden destruction of the tree canopy, seems to have resulted in a very marked deterioration of the soil, and restocking is not going to be an easy matter. In these sowings, although germination has been reasonably good, the majority of the seedlings have succumbed, many to insect attack but the majority apparently from drought (it will be remembered that the rains ceased a full month early in 1918). A careful examination was made to see whether the insects killing the seedlings were of the species which could multiply in the dead and dying timber lying about; this did not prove to be the case, the damage being seemingly mostly due to crickets, grasshoppers and the like, and to a minor degree to Melolonthid larvæ.

IV. Broad-leaved Trees.—It has now become a very patent fact that successful fire-protection results in the encroachment of oak and other broad-leaved species on the chir areas, so the effects of fire on these associated species is of importance. As a rule, these species affect cooler and damper spots through which fires either do not run or only burn quietly and the damage done to them is slight. In 1916, however, everything was so dry that the fires swept clean up through oak forest of nearly 2,000 feet vertical distribution on the steep northern slopes of Binsar Reserve, about as destructively as in the chir areas. Many old trees were killed but oak and its commonest associates, *Rhodendron* and *Pieris* are both wonderfully resistant and develop dormant buds if only the narrowest strip of bark remains alive, the usual place where the new tufts of leaves are noticed being about half way up the main stem in the young tree, everything above and outside having been killed off: such survivors will often be found where all the intermingled chir have been destroyed and, if in any numbers, will remove all chance of the chir again occupying the area unaided.

V. Herbaceous Vegetation.—It remains to examine the effects of fires on the grass and herbaceous vegetation. There is a very

widespread belief that annual firing improves the grass crop both in stimulating the growth of the fodder species and in checking the spread of the coarser kinds. In ordinary years this is very probably true, but the incendiaries of 1916 must have been sadly disappointed if this was their object, for it was generally noticed that the intense fires seriously affected the vigour of the grass and, even two years later, its poor growth was noticeable in some areas, *e.g.*, Khabdoli South. A striking feature was the extraordinary abundance of a small composite annual (? *Anaphalis contorta*) immediately after the fires, literally whitening the ground; it has since been restricted to its normal limits and a luxuriant growth of *Rubus ellipticus* and a good deal of *Desmodium parvifolium* now occupy much of the vacant soil. It is regretted that no careful surveys were made of the flora before and after the fires.

All these considerations tend to lead up to three connected problems, namely, (i) the direct and indirect financial loss resulting from the fires, whether holocausts like those of 1916, or the more normal type; (ii) the methods for preventing and combating them, from both practical and financial aspects; and (iii) the results of fire-protection. These important matters have not been lost sight of, but their full discussion would lengthen this note beyond reasonable limits if these have not already been exceeded, and so they must be left for another occasion, or a more competent pen.

[This article was shown to the Forest Botanist with a view to elucidation of the cause of deferred dying of trees after severe fires.

Mr. Hole writes :—

"It is quite possible that the deferred dying alluded to is due to interference with the normal "sap-circulation" and to a general slowing down (*a*) of the upward water-current in the wood, and (*b*) of the downward flow of organic food in the inner bark, due to the weakened, damaged cambium being unable to supply the normal increment of new and efficient conducting elements. The author notes that one effect of the fire is to diminish the increment *at the base of the trees.*

"Deferred death might well occur in such a case, very much as it sometimes does in cases of girdling in which trees of some species often struggle for several years to re-establish normal conditions before they finally die.

"Mr. Champion might be asked to send us specimens of needles in alcohol of normal and sickly trees, respectively, for examination. The needles of the sickly trees *may possibly show an abnormal accumulation of starch.*

"There is also another possiblity which might be borne in mind. Mr. A E. Osmaston recenly sent us specimens of the roots of two *chir* trees which were standing 7 feet apart, the death of one having been followed by the death of the other. The trees were said to be overmature and had been attacked by boring beetles and thus were probably sickly individuals, although nothing was said about fire damage in that particular case. These *chir* roots proved to be full of the hyphæ of an apparently parasitic fungus This or a similar fungus might well be responsible for finishing off trees which had been already damaged by fire. Mr. Champion might be asked to send us specimens of the roots of sickly and normal trees."

Mr. Champion has been asked to send specimens of needles and of the roots of trees damaged by fire for examination by the Forest Botanist.—HON. ED.]

WORKING-PLANS.

(Contributed.)

The standard of working-plans in India leaves much to be desired. There are various reasons for this. The paucity of sylvicultural knowledge, the lack of statistical data and the inaccuracy of much of the data which does exist, all affect the quality of the working-plans produced but, apart from these points which time and research alone can rectify, there is room for great improvement.

Bad methods are very largely responsible for the poorness of the plans. I propose to try and trace some of the faults in the present working-plan organization and to suggest a few modifications. Things are already moving in the right direction but they are moving very slowly.

2. In provinces where there is no Chief Conservator, a preliminary report is first written. In the only cases of which I have experience, this report has been written by the Divisional Forest officer. If reference be made to the subject-matter of such a report, it will be found that it covers all the essential parts of the working-plan—in fact, if well done, it includes the most important part of the business of making a plan, and the only work left should be the filling in of the details to carry out the preliminary report. But the preliminary report in practice is nothing of the kind.

Sometimes a D. F. O. merely writes anything in order to get the report done and nobody takes any particular notice of it—as a Conservator once said to me it is "only to start the ball rolling." Nobody can blame the D. F. O. He has already far more work than he can do properly, he is worried by Babus, budgets and buildings, and his judgment is extremely likely to be obscured by some particular point which has been causing him recent trouble. Even if he is more conscientious than this, he has usually had no real experience in working-plan matters; and his preliminary report is often a collection of various vague pseudo-scientific memories of "a regular series of age gradations," which he has not thought about since he came out ten, fifteen or twenty years before. As a result the working-plan officer on arrival is either seriously misled by the report or spends months finding out its faults, getting it cancelled and writing it afresh.

Such preliminary reports are not worth the paper they are written on, and waste everybody's time. A D. F. O. is expected to be an expert in half a dozen different branches of his profession and to add an occasional preliminary working-plan report to his duties for luck is about the last strand.

3. When there is a Chief Conservator, a preliminary report is often dispensed with and the W. P. O. starts with a clean sheet. But this is not ideal either. There are many points on which a W. P. O.'s ideas are always vague; and even if he does finally acquire a sufficient knowledge of them, it is only after the expenditure of considerable time. I refer to such matters as labour supply at different seasons, small local demands, peculiarities of contractors and local methods, etc.

4. During the compilation of a plan the W. P. O. has to obtain sanction to his various propositions, as he goes along, either from the Inspector-General or the Chief Conservator through his circle Conservator. This has a greal deal to do with the trouble, for the sanctioning of the plan in patches clouds the perspective of both W. P. O. and Conservator. Presumably both the Inspector-General and Chief Conservators have a great deal of work besides working-plans, and, though some Inspector-Generals

and Chief Conservators may have had extensive working-plan experience in their young days, they surely cannot have much time to spare to keep up to date in the more technical matters in addition to their other duties, nor can they know intimately all the forest divisions where they have to decide these matters. There must be Conservators who are not specialists in the subject —possibly there are some who have never made a serious working-plan in their lives.

Yet Conservators (and the higher authorities) are largely responsible for plans and have to make various notes and suggestions on them. As a consequence, such notes are necessarily often an obvious compromise showing a lack of sufficient knowledge to reject a new proposal and a fear of wholly accepting it either. A rotation perhaps has been 150 years in a former plan. A W. P. O. spends weeks inspecting and measuring and days of thought, and comes to the conclusion that the correct rotation for the moment is 100 years, and gives his reasons for this. Back comes the proposal with no answer to his arguments and no reasons—merely a note "I think it should be 125 years" and 125 years it is. Obviously the compromise of nervous inexperience.

Now those Conservators whose forte is not working-plans cannot be anxious to do all the additional work they have to do in connection with a plan, and yet they wish to be consulted on far smaller points than they would dream of asking about in the running of a division. Why?

Simply because they do not trust the judgment of their W. P. O.'s sufficiently, and can anyone possibly blame them considering the men who are often put to make working-plans.

In one province I recall offhand that the plans of four of the largest and most important divisions have been revised in the last few years. *Three of them were done by men with one year's service when the plan was commenced*, and in the fourth the man only had five years' service. In all cases, the knowledge these men had of the sylviculture of the species when they began their plans was practically nil.

Can anyone then be surprised that Conservators, Chief Conservators and Inspector-Generals are unwilling to trust the entire compilation of a plan to the W. P. O. ?

5. I have heard it stated that working-plans are given to junior men because they are fresh from home and up-to-date, whereas a more senior man has often forgotten much that he learnt. This may be partly true, but a far more potent reason is that nobody wants to make a working-plan as things are; it is extremely hard work, has a great many petty inconveniences and unpleasantnesses attached to it, gives one absolutely no authority, and in practice (though not perhaps in theory) ties one up for a couple of years or more, with no chance of leave till the work is done.

The extra remuneration given for this is Rs. 100 per month. It might attract a man at the end of his first year but it certainly does not do so later. Personally, I would not willingly undertake most working-plans at double that sum under present conditions.

6. And the nett result of junior men making plans in combination with Conservators who, however willing, cannot be experts in everything ?

The following quotation from a recent plan will show :—

"As there are at present no experimental results to show what grades and intensities of thinnings best suit the *sal*, the prescriptions inserted here are only based on general considerations.

Grown in the open, the *sal* seems inclined to form one or more large branches below the main crown, thus limiting the length of bole ; if a dense crop is suddenly opened out, the trees seem inclined to form epicormic branches. This indicates that the crop should be kept fairly dense till the principal height-growth is completed. Grown in dense crops, the *sal* forms a rather long and very narrow crown ; but, as far as can be judged, it is capable of developing the more rounded crown necessary for good diameter increment and at the same time a clean bole if opened fairly late in life.

Where, however, this extra crown development is taking place, very one-sided crowns occur if the trees are at all congested.

Taking the above points into consideration, it seems advisable to keep the trees rather crowded till the principal height-growth is completed. Then, however, the crowns must be given plenty of room, and at the same time the lower parts of the boles must still remain shaded to avoid the formation of epicormic branches. For this latter condition, 'crown thinnings' do just what is required.

Up to the stage of the completion of the principal height-growth, however, crown thinnings cannot be undertaken for various reasons, among which may be mentioned the difficulty of choosing properly the trees with the best future in such a young crop. If crown thinnings were adopted so early in life, there would be great danger of producing a crop of short-boled, large-crowned trees.

At present the material from thinnings in the quite young crops is unsaleable, and, as a general rule, it would be inadvisable to go to the expense of thinning where the produce is valueless. In these younger crops, if the dominating trees are well spaced and their crowns not too cramped, it probably does little good to perform an 'ordinary thinning.' In many of the groups, however, the spacing of the dominant trees is uneven and the whole crop often very congested. In such cases, thinning ought certainly to be done even if the produce is unsaleable. The decision as regards an individual group must rest with the marking officer, but subject to that the following method of thinning is suggested until more certain knowledge is available :—

"*(a) Crops, the principal height-growth of which is not yet completed.*

Where necessary, moderate or heavy ordinary thinnings (B or C grade) depending on the density of the crop.

(b) Crops, the principal height-growth of which is complete.

Crown thinnings at first light, but becoming progressively heavier as the age of the crop increases.

N.B.—In the classification of thinnings it will be seen that class 5 trees (dead and dying) are down for removal under all grades of thinning. Their removal does no good sylviculturally and their retention does neither good nor harm. From the financial point of view, as they are dead capital, the sooner they are removed the better; but if they are unsaleable, then their removal, even from this point of view, is uncalled for as it would be incurring expense for which no return, either sylvicultural or financial, would be obtained. Therefore no class 5 tree should be removed unless it is saleable."

Now is all this necessary or even desirable in a working-plan? Conceivably it contains a certain amount of useful observation about the *sal*, but Part II of a working-plan should be merely a set of prescriptions to guide the D. F. O. in his work with a brief and concise account of the general aim of the plan and the methods of attaining that aim. It should not contain detailed soliloquies on the methods of thinning *sal* crops.

Of all the above, all that the D. F. O. requires is something like the following:—

" It is considered that the best results will be obtained by keeping the trees rather crowded till the principal height-growth is completed, after which the object should be to give crown space to selected trees.

Whether the expense of thinning is to be incurred in crops so young that the produce is unsaleable, is left to the D. F. O.'s discretion. The method of thinning will be therefore:—

(*a*) *Crops, the principal height-growth of which is not yet completed.*

Where necessary, moderate or heavy ordinary thinnings (B. or C. grade) depending on the density of the crop.

(*b*) *Crops, the principal height-growth of which is complete.*

Crown thinnings at first light, but becoming progressively heavier as the age of the crop increases.

N.B.—Class 5 trees should not be removed unless saleable."

I have calculated that in the plan from which the above quotation was taken Part II could have been adequately written, from the D F. O.'s point of view, in about one-fifth the space it actually occupied. The first point that strikes most of us when we first see an Indian working-plan is its appalling length and discursiveness, and to my certain knowledge D. F. O.'s often do not attempt to read them, they only look at the essential points.

Why then did the W. P. O. write all the above? Simply because, under the present methods, all reasons *have* to be given in detail to the Conservators who naturally will not pass things proposed by a man of one year's service unless he makes out a proper case and, moreover, the Conservator needs the details in order to decide whether the proposed prescriptions are the best—obviously, he cannot know all such details himself for a whole circle or province.

This is not imagination on my part, for I have experienced this repeatedly. In one case, I proposed exactly the above prescriptions for thinning a *sal* forest, but giving none of the details, and sanction was refused.

The D. F. O. does not want these details except in a very general way, he needs simply a plan of work to carry out.

7. Admittedly, if the plan is to be of any real use, it must be well made, and the compilation of a plan needs more skill than its application. Instead of men with one year's service making plans, they should be men with experience in divisional work, a technical knowledge of the art of working-plan compilation and only picked men.

8. How then can an improvement be effected? Probably a man with 8 to 15 years' service has the correct amount of Indian experience and a man of this service would be thoroughly trusted by Conservators.

But as things are, a man forgets all he ever learnt about compiling plans after eight years of divisional work.

The first and most important point is to *offer* the making of a plan to a selected man, giving him the option of refusing, and to make the pay and status of W. P. O.'s such that these posts are

sought after and men are thereby encouraged to keep up to date in working-plan matters.

I would suggest that all W. P. O.'s be paid Rs. 250 per month plus a bonus when the plan is completed. If this does not attract the best men, increase the pay till they are attracted. The market value of working-plans will soon find its right level if men are allowed to refuse the posts.

It seems fairly obvious, however, that with nobody keen on making working-plans and a man being ordered to do a job he does not want to do that the highest standard is unlikely to be attained.

9. When a W. P. O. takes up his duties he should be given a preliminary report written by the D. F. O on the following points :—

(1) Neighbouring agricultural customs and necessities.
(2) Distribution and area.
(3) Boundaries.
(4) Rights and concessions.
(5) Statistics (references only).
(6) Dangers.
(7) Marketable products with possible new demands.
(8) Lines of export with suggested changes.
(9) Cost, method and agency of exploitation with suggested changes.
(10) Current prices.
(11) Forest staff.
(12) Labour supply.
(13) A miscellaneous chapter indicating any special local points which affect management.

On all the above points the D. F O. knows far more than the W. P. O. ever finds out for himself. The D. F. O. should be responsible for the accuracy and completeness of the above information and his report should be the W. P. O.'s authority on those points.

After six months in a division a D. F. O. could write such a report in a few hours, whereas it takes a W. P. O. weeks of questioning, and even then he misses lots of local points.

The other sections of Part I of a plan can be investigated better by the W. P. O. than by the D. F. O. The D. F. O.'s report should be facts not fancies.

13. The W. P. O. should then inspect the division with the object of writing a detailed "working-plan report." He should not be expected to produce this within five minutes of his arrival.

Properly done, this working-plan report should be practically the final plan, but without the actual details and figures. That is to say, it should settle all such questions as the working circles to be formed, the felling series, the objects of management, the adequacy of the division into blocks and compartments, the period of the plan, the sylvicultural systems, the likelihood of change in the rotation, the periods or felling cycle, the method of valuation to be adopted, the way the yield is to be calculated, questions of regeneration, other sylvicultural operations, roads, buildings, labour, etc., etc., with, of course, all facts on which the proposals are based and *detailed reasons for all the proposals.*

Possibly certain preliminary data would need to be collected for the above which would entail more than actual inspection.

Such a report, however, could be compiled in a division of 300 to 400 square miles in some six months to one year.

Once compiled, the skilled work of the plan would be finished. All that would remain would be the pure spade work to enable the final plan to be compiled. I refer to such work as enumerations, the detailed description of compartments, stock mapping, etc., etc. To keep a highly paid official for months on such work is uneconomic and sickens the W. P. O. It requires little skill, and for a man who has interested himself in schemes of management and their improvement means stagnation. His mental faculties must be alert when he makes the final plan, and he must not be stale.

14. Once, however, this working-plan report is passed, it should be regarded as the form in which the final management will be laid down and should not be changed without very good reason. The necessary data which it asks for should be collected

by a subordinate working-plan staff, while the W. P. O. goes off to do his own skilled work in some other division. Once the data were collected, it would not take him more than a month's work in head-quarters to write up the final plan.

In this way, a good man, with three Extra-Assistant Conservators to help him, could make three plans in the time he now makes one. His pay would be attractive enough to get the best men, his work would be interesting instead of the present deadly monotony for the greater part of a W. P. O.'s time and consequently better plans would be produced, and the total cost to Government would certainly not be more—and would probably be less—than it is now.

At present a W. P. O. averages 2 to 3 years on a plan for 300 to 400 square miles. Fully two-thirds of that time he is doing work which could be done equally well by any trained forest officer on half his pay.

15. The above detailed *preliminary* report should go—not through the circle Conservator—but though a provincial working-plans branch with a Conservator at its head to the Chief Conservator or the Inspector-General as the case may be. Till there are provincial branches there should be at least one central branch (say an officer in the Sylviculturist's office at Dehra Dun), through whom all these reports should go to the Inspector-General or Chief Conservator. This branch should note on the report. Naturally it could not pass any *orders*, but such notes would often be a help to the Inspector-General or Chief Conservators in forming an opinion on a proposal.

Differences of opinion on fundamental points should be recorded in the introduction to the plan.

16. Once the data, etc., necessary for the plan had been collected, the W. P. O. should write it up, but in this final plan many of the details in the working-plan report should be omitted, and the object should be to put everything as concisely as possible. For example, the passage quoted in paragraph 6 would be suitable in the working-plan report, but in the plan itself it should be cut down as shown.

The working-plan report should be printed for record with the notes of the working-plan branch and the final orders of the Chief Conservator or Inspector-General on it.

17. Certain of the above suggestions could be inaugurated now, if the powers that be agree to them, without any question of increased payment for W. P. O.'s, better staff, etc., namely—

(*a*) The preliminary report *by the D. F. O.* mentioned in paragraph 9. (I know of a case where the possession of such a report by the W. P. O. would have saved the expense of marking some 3,000 acres which were never felled.)

(*b*) The submission of a proper working-plan report by the W. P. O. containing all the fundamental scheme of management as suggested in paragraph 13.

(*c*) The writing of Part II of the final plan *as briefly and concisely as possible* without frills or fancies. Part I, of course, should be as full of information, within reason, as possible.

(*d*) The recognition of the fact that a W. P. O. need staff as much as anyone else, and that his work is even more important than that of a D. F. O. Instead of leaving a W. P. O. to pick up any unskilled staff he can find on daily labour, he should be provided with the men necessary for his work from the rangers, etc., of the permanent trained staff supplemented by daily labour where suitable.

"X."

[NOTE.—Our contributor in a forwarding letter has explained that he does not wish to imply that Conservators are more or less incompetent to deal with working plans. He wishes to convey that in compiling working-plans we should have a specialized agency capable of advising Conservators. The multifarious duties and enormous charges of the latter preclude the degree of attention to working plans which, in many places, is now essential to progress, both sylviculturally and economically. There is a good deal in the suggestion, and we shall welcome the discussion of this subject in our pages.—HON. ED.]

INDIAN SPECIES OF *CARISSA*.

BY H. H. HAINES, I.F.S.

Among the numerous materials recently in demand as sources of tannin have been Karaunda bark and Karaunda leaves. In Mr. Pilgrim's paper read before the Tannin Conference at Delhi in 1917, the Karaunda was specifically referred to as *Carissa spinarum*; but, as a matter of fact, more than one species have been collected. It is possible that all are not equally valuable but the different species of Indian *Carissa* are much confused in Herbaria, and as it seems to me, in the Flora of British India.

2. In the Prodromus, De Candolle enumerates seven Indian species, or, including *C. inermis*, which he calls 'less well known,' eight species while *C. suavissima*, Beddome, has since been added. The Flora of British India reduces these nine specimens to five only.

3. There are only two Linnean species of Carissa, *viz.*, *C. carandas* and *C. spinarum*, both of which are recognized by De Candolle. The first **C. carandas** may be taken to be, without doubt, the plant figured and described by Roxburgh under the same name, and again figured and published by Wight in his Icones (t. 426). The same species was also figured by Lamarck (Ill. t. 118).

The description by Roxburgh is excellent, but that in the Flora of India read in conjunction with the description of *C. spinarum* would lead one to suppose that there is not much difference between these two species. These descriptions have led large erect forms of *C. spinarum* to be classed as *C. carandas*.

C. carandas, L., is very easily identified by its erect habit, oval or oblong leaves with rounded ends and with distinct reticulate nervation, its somewhat large flowers and relatively broad petals, and its large berry (Plate 17, fig. 1).

A character in the genus sometimes mentioned but insufficiently emphasized, but which I have found to be *remarkably constant*, is the number of ovules. In *C. carandas* this number is usually 8,

and I have always found 8 in fresh specimens. In very old dried material I have sometimes only been able to discover 6. I believe that *C. carandas* is very rarely, if ever, wild in Northern India, the Central Provinces, Bihar and Orissa or Bengal, but further information is desirable with regard to the United Provinces and Eastern Bengal.

4. Omitting, for the present, certain other forms included under this species in the Flora of India, there is no difficulty about *C. carandas* and I proceed to discuss the next Linnean species **Carissa spinarum,** L. (Plate 17, fig. 2).

There is a quite erect shrub or even small tree which, for the nonce, I will refer to by one of its venacular names *Kanuwan,* quite common over the drier sandy parts of Bihar and Orissa, in Upper India and the Central Provinces. It has often exceedingly stout forked thorns and ovate leaves so that it comes equally well under the description given in the F. B. I. of *C. carandas* or *C. spinarum,* and the same plant is in fact included under both designations in the Calcutta Herbarium. Under the name *C. spinarum* in the F. B. I. is also included a small diffuse shrub called *C. diffusa* by Roxburgh, the identity of which is perfectly well known from Roxburgh's description and drawings. But no botanist who has seen both these shrubs in their native state would unite them under one species, so that if *C. diffusa,* Roxb., is *C. spinarum,* L. (the author is given as A. DC. in the F. B. I.), then the common *Kanuwan* is *not C. spinarum.* In the absence of the type plant of *C. spinarum,* L., which I have not seen, it is necessary to fall back upon the original descriptions and figures.

The species is first published in the Mantissæ to the Species Plantarum as the "*Carissa with ovate acute leaves*"; and although this diagnosis clearly differentiates it from the typical *C. carandas,* it does not differentiate it from *C. diffusa.* In Willdenow's edition of the Species Plantarum, however, he adds that it is "a tree with spreading trichotomous and dichotomous branches and opposite spines, ovate rather acute smooth coriaceous leaves and *small* flowers 5—6 together on very short peduncles. Corolla lobes linear, emarginate, a little shorter than the tube." This sufficiently

Photo.-Mecl. Dept., Thomason College, Roorkee.

Fig. 1.
Carissa carandas, L.

Fig. 2.
Carissa spinarum, L, typica.

excludes Roxburgh's species which never remotely resembles a tree. By 'emarginate' Willdenow probably refers to the margin being somewhat involute, as no Indian Carissa has emarginate petals in the modern meaning of the term. It is stated that this tree is a native of India.

Lamarck again gives a very good figure of *C. spinarum* as he understood it, although it represents rather a narrow-leaved form of the plant, and I again refer to this figure later on. For the rest the description better suits our *Kanuwan* than it does any other species, and as the name is well known and suitable it seems reasonable to retain it for the common *Kanuwan* (described in detail by me below).

De Candolle in the Prodromus expands the description of *C. spinarum* and rightly adds "leaves elliptic or ovate," but he fails to distinguish the elliptic leaves of *C. spinarum* from those of *C. carandas* and he does not improve matters when he says (in spite of the figures quoted by himself) "nervis utrinque perspicuis," which seems to show that he also had mixed with it in his herbarium specimens of the next species, especially as he says its native country is Coromandel.

The real differences between *C. spinarum* on the one hand and both *C. carandas* and *C. diffusa* on the other, are the more or less rhomboid or angled base of the leaf of *C. spinarum* with a very wide angle in the ovate leaves and a narrow angle in the more elliptic leaves; and secondly, the very inconspicuous unbranched nerves which show as delicate translucent veins, not looping, whereas those of *C. carandas* and *C. diffusa* have conspicuous looping nervation. Thirdly, the small flowers of *C. spinarum*. Lastly, a most important difference between *C. spinarum* and *C. carandas* is that the *ovary is never more than 2 or at most 4-ovuled.*

Now as regards this important point, most authors are silent; and, in other cases, one cannot be certain whether the plant examined was the precise form now referred to. In *all specimens* examined by me the ovary cells have been 1-ovuled only. Kanjilal states that the cells are 2-ovuled but (first edition of his Forest

Flora) goes on to say: "Sir D. Brandis says the berries are 4-seeded. But I have examined hundreds of them from different plants without ever finding more than two 2 seeds in any." This last valuable statement is obviously a matter of original observation, whereas it is possible that the cells being 2-ovuled is taken on faith. It is certainly significant that the fruit is never more than 2-seeded if the ovary is often 4-ovuled! Cooke also says that the cells are 2-ovuled, but he mixes up *C. diffusa* with *C. spinarum*, and, as I show later on, there is possibly a third species (*C. congesta*) not differentiated. The Dehra Dun and Jaunsar plant is well represented in the Calcutta Herbarium and all the specimens show the cells 1-ovuled, and this observation has been confirmed by Mr. Narainswami of the Botanical Survey, whom I asked to kindly examine one specimen. Besides these, I have examined specimens from Chota Nagpur, Gwalior, Oudh and Burma and the varieties hereafter described from South India.

5. **Carissa diffusa,** Roxb., is very clearly delineated by its author both in his drawings and in the diagnosis, and it would seem that De Candolle merely drew his description from the latter without having before him, or at least without recognizing, the authentic specimens. This species also occurs mixed up with the last two in the Calcutta Herbarium. (Plate 18, fig. 4.)

Roxburgh's unpublished drawing is practically reproduced by Wight in his Icones (t. 427). The plant is described as "shrubby and diffuse with scarcely any stem but forming a low broad rigid thorny bush, leaves roundish-ovate-cordate, all of a firm polished shining texture, each ending in a short subulate somewhat recurved point." He states that it is a native of Ganjam and from there to the mouth of the Hooghly. It is, indeed, as I have observed, one of the commonest features of the laterite scrub of Orissa which is included in the region indicated. Its habit is very distinct, but if allowed to grow up (the scrub jungles are heavily browsed); and if my variety 'scandens' is not a distinct species, it becomes, not as does *C. spinarum*, an erect shrub but scandent. (Plate 19, fig. 5.) Its shrubby habit is analogous, therefore, to that of some of the Indian garden Jasmines, bushy from being pruned. As it enters

Photo.-Mech. Dept., Thomason College, Roorkee.

Fig. 3.

Carissa spinarum, L., var. *paucinervia*.

Fig. 4.

Carissa diffusa, Roxb. typica.

the forest, however, it is apt to lose its roundish-ovate-cordate leaves and these become more oblong, so that it is much more like *C. carandas* than *C. spinarum*. *Finally its ovary is 4-ovuled !*

6. **Carissa salicina,** Lamk. (Dic. I, p. 554) is a fourth Indian species described by De Candolle. The leaves are said to be lanceolate-oblong, mucronate, glabrous with lucid veins, thorns simple, flowers fascicled small sub-corymbose. He suggests that it is a variety of *C. carandas* but with leaves twice as narrow, flowers much smaller and petiole shorter, with the habit of a *Salix* or Almond, I am unable to identify the species. Sir J. D. Hooker questions whether it might not be a synonym for *C. paucinervia* and I think it may be left at that.

7. **Carissa paucinervia,** DC. (Plate 18, fig. 3) is admitted as a separate species in the F. B. I. It is figured by Wight (Ic. t. 1290) and was, rather significantly as I think, mounted on the same sheet with *C. spinarum* in Wallich's No. 1678. Sir J. D. Hooker says it is "a small ramous shrub with the habit of *C. diffusa*" (which, however, he united with *C. spinarum*), and he adds "probably as Beddome conjectures "a variety of that species" whereas Beddome says it is a variety of *C. carandas !* To my mind it is indeed a variety of *C. spinarum*, L. (as limited in this paper), and probably this is what Sir J. D. Hooker meant. It is not a small shrub with the habit of *C. diffusa* but an erect shrub with the habit of *C. spinarum*, and with every character of that species except only narrower elliptic-oblong leaves. Lamarck's figure referred to above under *C. spinarum* would also do for this species very well. It appears to be especially a mountain form of *C. spinarum*, but some of the specimens from Mahendragiri are *true C. spinarum*, and I have repeatedly observed plants more or less intermediate. On the theory that it is merely a variety of *C. spinarum*, the Monghyr locality questioned by Hooker becomes quite probable, and it is to be noticed that De Candolle also mentions Benares as a locality. The ovary is 2-ovuled in the specimens examined by me, *exactly as in C. spinarum !* Since writing the above I have noted that Wight shows the ovary cells of this species as 1-ovuled

in his analysis, which confirms my observations under *C. spinarum* and the close connection of this species to that.

8. **Carissa hirsuta**, Roth., Nov., Pl. Sp., p. 128. This is a very pubescent or even sub-tomentose form of Carissa described from India as having orbicular ovate leaves with the nerves sub-tomentose both sides, very obtuse, petioles tomentose, calyx and corolla lobes lanceolate but corolla glabrous. The description agrees fairly well with a very pubescent form of *C. spinarum*, and as *C. hirsuta* has generally been considered to refer to such, I have retained the name for these pubescent races of *C. spinarum*, though not only the ovate-leaved form but the narrow lanceolate (*paucinervia*) form is occasionally (as in Fischer's No. 922a) very tomentose.

9. The last variety (*C. hirsuta*) has usually been considered to be the same as Roxburgh's **C. villosa** (Wight Ic. t. 437), (copied from Roxburgh's original drawing), but that plant looks to me quite different and belongs to the '*diffusa* group' with four ovules. All the variety *hirsuta* (including Fischer's) have one ovule only in each cell. Wallich's **Carissa villosa** No. 1680B is indeed very like Roxburgh's figure and this also belongs to the *diffusa* group with four ovules and reticulately veined leaves.

10. The last of the better known species described by De Candolle is **Carissa macrophylla**, Wall. He disposes of it in a few words relying apparently on the hooked thorns as a sufficient character. He states that the leaves are ovate, acuminate, glabrous and shining, and the flowers in terminal and axillary corymbs. As the spines or thorns are often very slightly curved, the description is very inadequate. Hooker describes it as 'shrubby, erect,' probably on Beddome's description of *C. Dalzellii* in the Flora Sylvatica. Specimens collected by me and by Mr. Haslett in Orissa, and which agree very closely with Wallich's type No. 1679C, were widely scandent! I can hardly doubt its being the same (although Wallich's specimen has neither flower nor fruit) and it is a very distinct species, though the description of it differs in several respects from that given in the F. B. I. But Hooker identifies *C. macrophylla* with *C. inermis*, Vahl.

Photo.-Mecal. Dept., Thomason College, Roorkee.

Fig. 5.

Carissa diffusa Roxb., var. *scandens*.

Fig. 6.

Carissa inermis, Vahl., var. *macrophylla*.

(the 'less known spécies' described by De Candolle) which, he says, was no doubt described from a spineless branch; and if there is no doubt about it, then under the existing, somewhat fatuous, International Rules the name, however inapplicable, will have to be, by priority of publication, **C. inermis,** Vahl. (Plate 19, fig. 6 and Plate 20, fig. 7)

11. **Carissa suavissima,** Beddome, is said to differ from *C. inermis*, Vahl., by its slender climbing habit, very small spines, broader paler leaves, the perfectly glabrous flowers and berries 2 inches long. As I have already indicated, Wallich's *C. macrophylla* (or *C. inermis*, Vahl.) seems to me to be often a climber and the flowers in my specimens are glabrous so that the Orissa plant equally well comes under the diagnosis of *C. suavissima*. A fuller description is required of Beddome's plant to make sure, as there are no specimens of it in the Calcutta Herbarium. Talbot considered *C. suavissima*, Bedd., the same species as *C. macrophylla*, Wall.; and as I have obtained two forms of the latter of which one has broadly ovate leaves as described for *C. suavissima*, I have, in default of further material, provisionally adopted this view.

12. Having dealt with the Linnean and De Candollean species, reference has to be made to two other very doubtful forms.

The first of these is **Carissa congesta,** Wight. (Ic. t. 1289). It is included under *C. carandas* in the F. B. I. without even being separated varietally, but the leaves are quite different from typical *C. carandas* being 1—2' broadly ovate, mostly rounded and mucronate at the tip. Wight described the sepals as ovate but they are lanceolate in Stocks's specimen. The corolla tube is also shorter than in *C. carandas*, being only ·4" long in Stocks's specimen.

It is probably indeed this plant which I take to be far more common in Western India than one would gather from the specimens available, which has given rise to the confusion between *C. carandas* and *C. spinarum*. Wight himself described it as *intermediate* between *C. carandas* and *C. paucinervia* (*C. spinarum*, Nobis). Talbot's form of *C. carandas*, figured in his No. 393, also

appears to me to be probably this. The nervation, larger flowers, broader petals and pubescent tube clearly separate it from *C. spinarum*. The ovules in Stocks's specimen in the Cal. Herb. are only 4, and the species should be kept distinct. The material in the Cal. Herb. is, however, insufficient for dissecting more than one flower.

13. Another puzzling form is the scandent *C. carandas* described by Talbot. I have seen no specimens, but typical *C. carandas* is so far from any tendency to climb that when mixed in too shady jungle it is apt to die off rather than throw out sarmentose branches, so that the plant is at least worth varietal if not specific rank. I have not seen specimens and have provisionally included it here under *C. carandas*, var. *Talbotiana* on the supposition that it has 8 ovules. If the ovary is 4-ovuled, it should either come near *C. inermis* (as the thorns are said to be curved) or near *C. diffusa*, var. *scandens*. It may be a distinct species, as I suspect it is.

14. The sub-joined Key summarizes the results of the discussion in the foregoing pages and detailed descriptions of the species now admitted are appended. The number of the section where the forms are discussed is added for reference.

Most of the species contain flowers of two sizes which do not apparently differ in length of style and stamens and makes comparison by size rather difficult on paper. *C. diffusa* is particularly variable in this respect. The position of the swelling in the tube due to the anthors is fairly constant, being at the top in the *spinarum* group, and rather lower down in the *carandas* group.

KEY TO THE INDIAN SPECIES OF *CARISSA*.

I. L. acuminate 2—5", nerves mostly looping and distinct. Sepals with setaceous tip. Corolla tube ·75—1·5 usually glabrous. Petals ·5—·7" long, over ·1" broad. Ovary 4-ovuled. Thorns curved.

Large scandent or erect shrubs	I. *intermis* [para. 10].
L. narrow with cuneate base	var. *macrophylla*.
L. ovate with rounded base.	? var. *suavissima* [para. 11].

Fig. 7.
Carissa inermis, Vahl., var. *suavissima*.

II. L. not acuminate, under 3·5", nerves distinctly looping and reticulate. Sepals ovate to lanceolate, tip not setaceous. Corolla tube ·4—·9", pubescent upwards. Petals under ·1" or more broad. Ovary 4—8-ovuled. Thorns straight (or somewhat curved in 2a).

A. Ovary 8-ovuled. Corolla tube ·5—·9"

Large scandent shrub. L. broadly ovate. Petals ·4—·5".	2 (*a*) *carandas* var. *Talbotiana* (?) [para. 13].
Large erect shrub. L. elliptic or oval.	2 *carandas* (proper) [para. 3].
B. Ovary 4-ovuled. Corolla tube under ·5" (except 4*a*). Large erect shrub. L. broadly ovate 1—2 long. Cor. tube ·4—·5", nervation not very prominent.	3 *congesta* [para. 12].
Scandent shrub. L. ovate to oblong, apiculate 1—2." Cor. tube ·5—·6." Pet. ·3—·4." Nervation prominent.	4 (*a*) *diffusa* var. *scandens* [para. 5].
Small diffuse shrub. L. broadly or orbicular-ovate, apiculate ·6—·16." Cor. tube ·4—·55". Pet. ·2—·4", nervation prominent.	4 *diffusa* (proper) [para. 5].

III. L. not acuminate under 2·5", nerves few neither looping nor *reticulate nor* usually distinct. Sepals lanceolate or subulate. Corolla tube under ·4", quite glabrous (exc. sometimes 5 *a*). Pet. ·06" or less broad. Ovary 2-ovuled (very rarely 4-ovuled ?). Thorns straight.

Diffuse shrub. L. ovate to narrowly elliptic. More or less pubescent all over.	5 (*a*) *spinarum* var. *hirsuta* [para. 8].
Erect shrub. L. ovate glabrous. Twigs and cymes sometimes pubescent.	5. *spinarum* (proper) [para. 4].
Erect shrub. L. narrowly elliptic glabrous	5 (*b*) *spinarum* var. *paucinervia* [para. 7].

APPENDIX.

1. **C. inermis**, Vahl., Sym. 3, 43; *C. macrophylla*, Wall. No. 1679; F. B. I., III, 631; *C. Dalzellii*, Bedd., Fl. Syl. II, clvii; *C. lanceolata*, Dalz., Bombay Flora., p 143; *C. suavissima*, Bedd.? Talbot For. Flora, 2, 208.

A very stout woody climber (or erect shrub f. Beddome and Talbot) with large conical or sometimes 2—3-fid thorns on the trunk and curved or nearly straight divaricate thorns ·5—·7" long on the branches. Twigs terete, glabrous. Leaves broadly or narrowly ovate, acuminate or lanceolate, 2—3·5" sometimes 4·5" long, tip very acute but scarcely mucronate, base very obtuse or rounded or cuneate, sec. n. 5—7 all sub-equally strong and rather indistinct or 2—3 lower from near the base much stronger and curved, the others very indistinct and reticulate Petiole ·15—·2". Cymes terminal or from the upper axils, sub-sessile or shortly peduncled, puberulous, 3-fld. or contracted, 3-chotomous and many fld.; pedicels ·15". Sepals subulate, ciliolate with setaceous tip. Corolla tube ·75—1" (or 1·5 Talbot) glabrous or slightly pubescent at top. Petals 5—6, linear with tapering tip, ·5—·7" long. Anthers close to top of tube, apiculate, somewhat lanceolate. Berry globose, 1" diam. and purple when ripe (ellipsoid f. Cooke).

Orissa, often on the top of hills, also in the plains. Courtallum, on a high hill, *Wall.* No. 1679. Nilgiris, *Gamble* No. 14330 and 20713. According to Beddome it is common in Coorg, S. Canara and on the Bombay Ghats. Talbot says "Western Ghats from the Konkan southwards to Courtallum, common in rain-forests along the Konkan and N. Kanara Ghats, abundant near the coast on the hills about Karwar. Fl. Jany-Feby. Fr. ripens June. The large plum-like fruit is very palatable." There are two well-marked leaf forms (see key), whether they represent different varieties or not, I cannot yet say.

2. **C. carandas**, L. Linn., Mant. v. I, p. 52; Roxb. Fl. Ind. 1, 687; Wight Ic., t. 426; Lamk. Ill., t. 118, fig. I; Beddome, Fl. Syl. II anal., pl. XIX.; Kurz. Fr. Fl., p. 169.

A large glabrous shrub or small crooked tree with rigid 2—3-chotomous branches and pairs of very strong often forked divaricate thorns 1—2″ long. Leaves 1—3·5″ long, broadly elliptic or oblong, rounded or sometimes retuse each end, or (var.) broadly ovate, rarely mucronate, sec. n. 4—8, distinct, looping and connected with intermediate and tertiaries, usually raised when dry. Petiole ·1″. Flowers in usually binate terminal peduncled, often rather lax cymes with peduncles up to 1″ long, pedicels ·1—·2″ long. Calyx puberulous, sepals ·07—·1″, ovate to broadly lanceolate, tip not setaceous. Corolla tube ·5—·9″ long, swollen and pubescent above the middle, petals narrow-oblong usually acute or the ends lanceolate, ·4—·5″ long, pubescent one or both sides Anthers inserted above the middle, oblong, not apiculate Ovary with 4 ovules in each cell. Berry ellipsoid ·5—·75″ long or 1″ in cultivated forms, 4—8-seeded.

Cultivated thoroughout India. Apparently wild in the Konkan, N. Kanara and Bombay Deccan according to Cooke and Talbot. North-West India; Banda, *A. S. Bell* No 11 A. (*Jangli Karandas*), apparently wild? Without precise locality, *Royle* (probably cultivated). Nilgiris, *Herb. Wight.* Godavari District, *Gamble* No. 16090. Coimbatore, *Fischer* No. 2068. Very frequent in the dry forests of the Prome District according to Kurz, who apparently correctly discriminated the species.

3. **C. congesta,** Wight. Ic. t. 1289; Talbot For. Flora. Vol. II, Fig. 393? Leaves 1—2 broadly ovate, mostly rounded and mucronate or apiculate at tip but sometimes sub-acute, base broadly rhomboid or rounded, sec. n. looping but less conspicuous Peduncles often divaricate up to 5. Cymes many-flowered, dense. Sepals acuminate or with sub-setaceous tips. Corolla tube ·4″ inflated a little above the middle and somewhat pubescent upwards, petals ·35—·4″ over ·1″ wide, tapering at tip, somewhat pubescent. Anther swelling above the middle. Rajputana, Aravali Range, Mt. Abu, *Stocks* No. 210. Coorg, *Jerdon* f. *Wight*; Talbot's figure No. 393 also seems to me to be this, it is not typical *C. carandas*; Northern Division, Madras, Cleghorn (without number) is possibly this.

4. **C. diffusa,** Roxb., Fl. Ind. (Carey Ed.) 1,689. Wall. No. 1680 b (Cal. Herb.) is this or a variety of this (*C. villosa*, Roxb. f. Wallich).

A dwarf shrub with very numerous diffuse or sub-erect branches or scandent, armed with straight rigid thorns as in the last two species. Branches sub-glabrous or usually pubescent. Leaves ·6—2·5″ broadly ovate to broadly oblong with sub-cordate or rounded base and acute or obtuse and apiculate apex, very shining with 3—6 conspicuous sec. n. spreading and then looping and reticulating, raised above when dry Petiole 0—·08″. Flowers in dense terminal or axillary pubescent, sessile or shortly peduncled, corymbose cymes, pedicels ·05—·07″ Calyx ·1—·15″ pubescent, sepals lanceolate acute. Corolla tube ·4—·55″ glabrous or thinly pubescent at or above the anther swelling which is a little above the middle of the tube, petals ·3—·4 or only ·2, oblong or oblong-lanceolate, glabrous. Berry ovoid or ellipsoid ·3—·5″, usually 4-seeded.

Distribution. All down the Eastern Coast from Balasore southwards, and also on the S.-W coast. Balasore, Cuttack, Puri, Ganjam, *Roxburgh*; *Hooper* No 39524, Madras, *Brandis*. *Fischer* No. 1885. Quilon, *Meebold* No. 12615, Ceylon 1859 T. T. Along the coast of South Andaman, *Kurz* is doubtfully this.

The two following varieties may be distinct species but appear to me to depend upon locality and especially on freedom from browsing.

α. **diffusa** proper. Dwarf, diffuse. L nearly all ovate ·6—1·6″, often with sub-cordate base. Corymbs sub-sessile. Corolla tube ·4—·55″. Berry ·3—·4″.

In open jungle, scrub jungle.

β **scandens.** Climbing with long straight thorns 1″ or more on the branches. L. 1·5—2·5″ very obtuse to sub-acuminate with petiole ·1″. Corolla tube ·5—·6″, lobes lanceolate ·3—·4″. Berry ·4—·5″ long ovoid. In higher jungle.

This last approaches very closely to *C. carandas* but is easily distinguished in the field by its habit, and in the herbarium by the apiculate and usually acute leaves and shorter narrower petals, and the number of ovules.

5. **C. spinarum**, Linn. Mant. App p. 559. Willd Sp. Pl. I, 1220, Lamk, Ill. t. 118, fig 2. Wall Cat. No. 1678A.

A large or small often pubescent shrub or small often straight tree with rigid 2—3 chotomous branches and pairs of strong often forked divaricate thorns, 1—2″ long Leaves ·5—1·8″ long, ovate or elliptic with usually rhomboid base and usually acute and apiculate apex, pale beneath ; sec. n. 2—3, not looping nor reticulate, indistinct, and not or scarcely raised when dry, petiole ·07—·15″. Flowers small, white, star-like, in usually binate, terminal, close or lax puberulous or pubescent cymes with peduncle 0—1″ long, more rarely cymes solitary or sessile or also axillary. Pedicels ·01—·13″. Sepals subulate-lanceolate ·07—·08″. Corolla tube ·25—·35″ long, glabrous (*exc.* var. *hirsuta*) anther swelling close to the top, petals narrowly lanceolate, often acuminate, ·2—·3″, puberulous externally or glabrous. Ovary cells 1-ovuled. Berry ellipsoid more rarely sub-globose ·25″.

All over upper India from the Punjab (ascends to 5,000 ft. *Parker*) and N.-W. Himalayas (ascends to 4,000 ft. in Jaunsar and Tehri-Garhwal, *Kanjilal*,) to the drier parts of Bengal and Burma ; less common apparently than its varieties in South India. Chamba, *Lace*, Jaunsar, *Gamble*. Banda, U. P., Gwalior, Dehra Dun and Kumaon common, Bihar, Chota Nagpur, Central Provinces.

Var. α **typica**. Erect, often 20 ft. high. Twigs usually puberulous. L. usually ovate with rhomboid base but basal angle of lower larger leaves often very obtuse.

Distrib. as above. Also Mahendragiri, *Gamble* 14136. *Fischer* and *Gage* No. 60 and No. 61, 4,700 ft.

Var. β **paucinervia**, DC. Sp. Prodr. viii, p. 333; C. salicina, Lamk.? Wall. No 1677. Erect. Twigs usually puberulous. L. usually narrowly-ellipsoid or rhomboid.

Distrib. Benares, DC Monghyr, *Ham ;* Chota Nagpur, occasional. Nilgiris, No 11645 and No. 20675 *Gamble*. *Wight* 1851. Nilgris, *Schmidt*. (Clarke's 11235 is intermediate).

Var. γ **hirsuta**, Roth. (*vide* para. 8). Diffuse or sub-erect with more pubescent branches and sometimes leaves pubescent.

Burma, Ruby Mines and Kyaukse, *Lace* No. 5792 and No. 4874. Kheri. No. 22146 *Inayat* Hazaribagh, (Baragaon) *Wood*.

Coimbatore, *Fischer* 922a. Sivoke Hills, *Gamble* No. 7560, is, I think, this variety. "Hills eastwards of Belgaum," *Dalzell* and *Gibson*. The variety is not natural, it includes two or more pubescent forms.

Many thanks are due to Mr. J. H. Gordon of Calcutta for the trouble he has taken in developing the negatives sent to him

NEW INDIAN SPECIES OF FOREST IMPORTANCE.

PART 4.

[*Continued from* Indian Forester, *Vol. XLIII, p.* 132, 1917.]

Previous parts of this list have included 345 species. The present part includes 48 and thus brings the total to 393 species.

Acacia Donaldi, Haines, *Leguminosæ*, (Ind. For. 1917, p. 88), Central Provinces, extending into Bengal.

Aspidopterys andamanica, Hutchinson, *Malpighiaceæ*, (Kew Bull., 1917, p. 99), Andaman Islands.

A. floribunda, Hutchinson, *Malpighiaceæ*, (l. c., 1917, p. 95), Assam.

A. obcordata, Hemsl., *Malpighiaceæ*, (l. c., 1917, p. 97), Burma.

5. **A. oxyphylla,** A. Juss., *Malpighiaceæ*, (l. c., 1917, p. 99), Assam.

Crotalaria Bidiei, Gamble, *Leguminosæ*, (l. c., 1917, p. 27), S. India.

C. Clarkei, Gamble, *Leguminosæ*, (l. c., 1917, p. 27), S. India.

C. sandoorensis, Beddome Mss., *Leguminosæ*, (l. c., 1917, p. 29), S. India.

C. scabra, Gamble, *Leguminosæ*, (l. c., 1917, p. 28), S. India

10. **C. shevaroyensis**, Gamble, *Leguminosæ*, (l. c., 1917, p. 28), S. India.

Daphniphyllum Beddomei, Craib., *Euphorbiaceæ*, (l. c., 1916, p. 268), Burma.

Ellipanthus neglectus, Gamble, *Connaraceæ*, (l. c., 1917, p. 26), S. India.

Eugenia discifera, Gamble, *Myrtaceæ*, (l. c., 1918, p. 239), S. India.

Farsetia macrantha, Blatter and Hallberg, *Cruciferæ*, (Jour Bo., Nat. His. Soc., XXVI, 1918, p. 220), Barmer. Rajputana.

15. **Grewia Hainesiana**, Hole, *Tiliaceæ*, (Ind. For., 1917, p. 316), Sub-Himalayan tract to Satpuras in Central India.

Hopea canarensis, Hole, *Dipterocarpaceæ*, (Ind. For. 1918, p. 575), S. Canara.

Ixora Butterwickii, Hole., *Rubiaceæ*, (Ind. For., 1919, p. 15), Burma.

Jambosa Bourdillonii, Gamble, *Myrtaceæ*, (Kew Bull., 1918, p. 239), S. India.

J. courtallensis, Gamble, *Myrtaceæ*, (l. c., 1918, p. 239), S. India.

20. **Leea Venkobarowii**, Gamble, *Vitaceæ*, (l. c., 1917, p. 26), S. India.

Melhani magnifolia, Blatter and Hallberg, *Sterculiaceæ*, (Jour. Bom. Nat. Hist. Soc., XXVI, 1918, p. 228), Jodhpur.

Meteoromyrtus wynaadensis, Gamble, *Myrtaceæ* (Kew Bull., 1918, p. 241), S. India.

Osbeckia courtallensis, Gamble, *Melastomaceæ*, (l. c. 1918, p. 242), S. India.

O. Lawsoni, Gamble, *Melastomaceæ*, (l. c., 1918, p. 242), S. India.

25. **O. lineolata**, Gamble, *Melastomaceæ*, (l. c., 1918, p. 241), S. India.

Phoebe goalparensis, Hutchinson, *Lauraceæ*, (l. c., 1916, p. 190), Assam.

Polyalthia Parkinsonii, Hutchinson, *Anonaceæ*, (l. c., 1917, p. 25), Andamans.

Pygeum sisparense, Gamble, *Rosaceæ*, (l. c., 1918, p. 238), S. India.

Rhododendron Cuffeanum, Craib., *Ericaceæ*, (Bot. Mag., 1917, t. 8721), Burma.

30. **R. decipiens**, La'caita, *Ericaceæ*, (Jour. Linn. Soc., XLIII, 1916, p. 473), Sikkim.

R. tanastylum, Balf. f. et Ward, *Ericaceæ*, (Trans. Bot. Soc., Edin., XXVII, 1917, p. 217), E. Upper Burma.

Rhynchosia arenaria, Blatter and Hallberg, *Leguminosæ*, (Jour. Bo. Nat. Hist. Soc. XXVI, 1918, p. 243), Jodhpur, Barmer.

Skimmia arborescens, T. And. Mss., *Rutaceæ*, (Jour. Linn. Soc., XLIII, 1916, p. 491), E. Nepal, Sikkim.

S. Wallichii, Hook. f. and Thom. Mss., *Rutaceæ*, (l. c., 1916, p. 492), Nepal, Sikkim.

35. **Solanum albecaule**, Kotschy, ex. Dunal. *Solanaceæ*, (Cooke Fl. Bom. II, 1905, p. 268), Sind.

Strychnos ænea, A. W. Hill, *Loganiaceæ*, (Kew Bull., 1917, p. 138), S. India.

S. andamanensis, A. W. Hill, *Loganiaceæ*, (l. c., 1917, p. 146), S. Andamans.

S. lenticellata, A. W. Hill, *Loganiaceæ*, (l. c., 1917, p. 159), S. India.

S. narcondamensis, A. W. Hill, *Loganiaceæ*, (l. c., 1917, p. 203), Andamans.

40. **S. Nux blanda**, A. W. Hill, *Loganiaceæ*, (l. c., 1917, p. 189), Burma.

S. tubiflora, A. W. Hill, *Loganiaceæ*, (l. c., 1917, p. 197), Andamans.

Syzygium palghatense, Gamble, *Myrtaceæ*, (l. c., 1918, p. 240), S. India.

Syzygium travancoricum, Gamble, *Myrtaceæ*, (l. c., 1918, p. 240), S. India.

Taxotrophis caudata, Hutchinson, *Urticaceæ*, (l. c., 1918, p. 149), Burma, Assam.

45. **Tephrosia petrosa**, Blatter and Hallberg, *Leguminosæ*, (Jour. Bo. Nat. Hist. Soc., XXVI, 1918, p. 239), Jodhpur and Jaisalmer.

Vernonia Fysoni, Calder., *Compositæ*, (Rec. Bot. Sur. Ind., VI, 1919, p. 343), S. India.

Zizyphus hysudrica, Hole, *Rhamnaceæ*, (Ind. For., XLIV, 1918, p. 505), N.-W. India.

48 *Z.* **truncata**, Blatter and Hallberg, *Rhamnaceæ*, (Jour. Bo. Nat. Hist. Soc., XXVI, 1918, p. 234), Jodhpur.

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NOTE ON MR. HOLE'S PROPOSED SYSTEM FOR THE REGENERATION OF SAL FORESTS.

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PART I.

In the *Indian Forester* for March 1919, page 119, *et seqq*, Mr. Hole contributes a most interesting and suggestive article on the regeneration of Sal Forests, and puts forward suggestions for a new system of management of Sal forests, based on the results of a long series of experiments carried out on the regeneration of Sal at Dehra Dun In the course of his article he considers shortly a number of possible objections to the system he advocates. It might be of interest to elaborate some of these objections, and to raise one or two more which, though not mentioned in the article, might have a bearing on the success, or failure, of the new method.

In three of the five possible objections with which he deals (*viz*, *b*, *d* and *e*), the necessity of a suitable organization of labour is mentioned, whilst objection (*e*) is that "The system requires

more labour than is likely to be available"; and this is got over by reducing the amount of work to be done in June and early July, when labour is more difficult to obtain to the broadcast sowings. The first and second weedings would then, presumably, be done at the end of the rains, and the hoeing during the cold or hot weather. The establishment of forest villages is suggested as a means of increasing the available labour supply. It is interesting, in this connection, to try and work out very roughly the amount of labour which would be involved in applying this system to an average Sal division in the United Provinces.

Mr. Hole advocates strips about 60 ft. wide. For the sake of simplifying the calculations, this width may be taken as 66 ft. or 1 chain. As present knowledge goes, 150 years is a fair average rotation for Sal, rather high if anything; whilst the Sal divisions at present average not less than 200 sq. miles. The regeneration period is 15 years. This 15 years in 150 gives us $\frac{15}{150} = 1/10$th the total area under regeneration. In the average division of 200 sq. miles this is $\frac{200}{10} = 20$ sq. miles, $20 \times 640 = 12{,}800$ acres under regeneration by strips. As the strips are 1 chain wide, each acre under regeneration involves a length of 10 chains or $\frac{1}{8}$th of a mile of strip. Hence $\frac{12800}{8} = 1{,}600$ miles of strip. On each patch to be regenerated in the 15 year period, four operations at a minimum are necessary: (1) Hoeing, (2) Broadcast sowing and collecting seed, (3 and 4) Two weedings. Hence each year $\frac{4}{15}$ of the area must be worked on $\frac{4}{15} \times 1{,}600 = 425$ miles of strip roughly of which $\frac{425}{4} =$ 106 miles are to be actually completely hoed up. Looked at in this light, it appears that the labour problem is one which it will be difficult to dismiss in two short paragraphs. It might, then, be worth while to examine, shortly, the conditions prevailing in one or two areas in Agra and Oudh. The Thano forest is an area of roughly 5,000 acres, situated in one of the most densely populated areas of the Dehra Dun flanked by the Markham, Jeoli and Lyster grants with the large villages of Thano and Bhogpur towards the

side facing the hills. In November-December 1918 the utmost difficulty was experienced by the sylviculturist in obtaining labour to weed and tend his experimental plots alone. The South Patli Dun in the Kalagarh Division is an area of grass-land central for a very large area of Sal forest, bounded by the Mundal and Palain valleys, the outermost Siwalik ridge and the Ramganga-Kosi watershed, comprising the Adnala, Kanda and South Patli Dun Ranges. It is practically uninhabited. Here is a case for the establishment of forest villages For a number of years past, continued attempts have been made to establish a forest village here on almost any terms, the result up to date being complete failure. Yet under the new system, not one, but several villages would be required, and, in addition to the work of fire-protection, road-work, etc., the villagers would be required to turn out at three seasons of the year to hoe, sow and weed many miles of strips I can vouch from experience, of the extreme difficulty of obtaining and keeping till May only 72 coolies, for enumeration work, in these parts.

In Oudh I am less familiar with the conditions, but in 1917-18, in North Kheri Division, the greatest difficulty was experienced in obtaining labour for the clearing of roads and lines alone. The establishment of forest villages here would again offer difficulty. Either large areas of very valuable forest would have to be cleared, or else the villages would have to be established in the Phantas, a matter of great difficulty if the experience of crop raising to eradicate grass in the Sarota Phanta is to be accepted as a typical case.

If then we take the rough average figures I have given and apply them to the Bahraich, N. Kheri, Haldwani, Ramnagar, Kalagarh, Lansdowne and Dehra Dun divisions, we have seven divisions with 425 miles of strip in each to be worked each year or 2,975 miles of strip. The expenditure involved in this for a return 150 years hence, when the lowest rate at which Government can borrow money, even at forced rates, is 4 per cent., *i.e.*, General Provident Fund—may well make the Financial authorities turn longing eyes towards canal projects, with their relatively quick

returns and eight per cent. profit. Gorakhpur Division has been left out of this, as it may be said that the Sal there approximates more to the Bengal-Assam type, also the smaller Sal divisions.

This leads on to the control and supervision of the work; and it is pertinent here to examine the experience which has been gained in this province by sowing and planting on a large scale. We can take the two large Sal nurseries at Ramgarh and Banki in Gorakhpur, and the work in the Etawah and Afforestation Divisions. The two big Sal nurseries mentioned occupy an area of several acres each. Ramgarh is quite successful and Banki very much less so; and the commonest reason given is that constant and continual supervision is necessary during the rains. Mr. Howard, formerly D. F. O., Gorakhpur, has stated that he considers it necessary for the D. F. O. personally to visit each nursery *once a week* throughout the rains for success, to be certain; and he attributes the success at Ramgarh and the comparative failure at Banki to the fact that while the former is accessible from head-quarters during the rains, the latter is not. The afforestation work in Etawah and the Afforestation Division yields much the same experience, it being considered necessary for the D. F. O. to go completely round each division once a month throughout the rains, for success to be attained.

Mr. Hole's strips are, roughly, 60′ × 180′. If we take them as 66′ × 198′, we have them 1 × 3 chains or approximately ⅓rd of an acre each. Reverting to the 12,800 acres under regeneration in the average division we have, therefore, 12,800 × 3 = 38,400 strips in each division. On each strip there are to be three areas to be regenerated, and each area requires four operations (hoeing, sowing, and two weedings). Assuming both weedings can be inspected together, we then have on each strip each 15 years 3 areas with three operations on each. That is, in any given year, work will be done on $\frac{9}{15}$ of the strips or $\frac{38,400 \times 9}{15} = 7,680 \times 3$ and these operations take place at three different seasons of the year: sowing at the break of the rains, weeding at the end of the rains and hoeing in the cold or hot weather. If the D. F. O. visits each strip once

for each operation, he will have to go round his division three times a year and each time inspect 7,680 strips, or over 200 a day if he takes a month on each trip and works on Sundays. At the risk of repetition it cannot be too strongly urged that the only hope of success in this work is continual personal inspection by the D. F. O. As the receipts and issues of correspondence in N. Kheri Divisional Office already total, I believe, some 15,000 a year and there is plenty of work in the jungle as well, this prospect is more likely to infect D. F. O.'s with Satyagraha than cause them to sing a Hallelujah chorus.

Another, and perhaps less important, objection is the difficulty of extraction. If the system involves the laying of strips in a definite direction, the strips must, in many cases, be laid across the natural lead from stump to road, and in countries much cut up by nullahs and ravines this is a consideration. We cannot, for very many years, lay out a system of "Black Forest" roads on which to base our strips. The direction of the strips at Schönmunzach in the Black Forest has been modified partly for this reason and stress is laid on it there. In this connection it is interesting to note that, although the area of the division is only about 6,000 acres and each kind of felling in the strip is about 70 feet, yet the D. F. O. said that, although he did not know the exact length of strips in the division, it was more than 150 miles, and was more than one man could properly supervise, and there is neither hoeing nor sowing there.

A sylvicultural point also arises. Page 129 (*b*) and (*c*). The width and the strips to be three-fourths the average height of the forest. Only alternate strips to be regenerated first. The intervening strips to be left till the young growth has attained the original height of the forest. Consider our forest with a rotation of 150 years, after the system has been in force for 75 years. Half the area is now regenerated, *i.e., every alternate strip.* Now a dilemma occurs. It must either be assumed that the full height-growth is completed in half the rotation, and that for the last 75 years of their life the trees do not grow in height at all, a very difficult assumption indeed, or we must suspend operation until the young strips have

attained their full height-growth, again very difficult, involving, as it does, a grave departure from the normality of the forest, or else we must now *reduce the width* of the remaining strips to make them conform to the reduced height of the side-shelter trees, a most complicated thing to put into practice, as, if it takes the same time to regenerate the narrower strips, as it did the wider ones, we are left at the end of the rotation with a very large number of very narrow strips of mature trees.

Any system for managing Sal involving the production of even-aged crops must, at present, be capable of being applied to irregular forest to convert it. If it cannot do so, then it cannot come within the bounds of the practical politics of the present century. It would, therefore, be interesting shortly to examine the considerations which have governed the prescriptions of "conversion to uniform" Sal working-plans in the past, and see how far Mr. Hole's system either conforms to those considerations, or justifies a departure from them. The two prime necessities are: (1) to make regeneration as certain as possible, and (2) to avoid a heavy sacrifice of growing stock. The second of these takes advantage of the fact that, in all irregular forests, over certain areas old trees preponderate, whilst over other areas the average tree is young, and the area has generally been chosen for Periodic Block I or Quartier Bleu which has the highest proportion of overmature and mature trees, and with regeneration already established [*e.g.*, Thano, Haldwani, Gorakhpur]. Under Mr. Hole's system the first consideration goes, as he can rapidly obtain regeneration whether it is already there or not. This gives the consideration of sacrifice of the growing stock full play, and with the system under discussion it appears that this sacrifice will be very great. The strips have to be about 60 ft. wide laid in a certain direction, alternate ones being regenerated, the rest being left for a very long time. The areas cannot then be chosen with any reference to the condition of the existing crop. If the oldest areas be chosen first, then alternate strips will be nearly two rotations old before they are felled, involving heavy loss. If this be avoided by choosing younger crops, then the old crops are becoming overmature and

the evil day is only being postponed, while heavy sacrifice is involved in felling younger crops. In any case, strip fellings must occur on the whole area in half the rotation, and the realisation of mature trees in the shelter strips will be a matter of difficulty, involving either a very short felling cycle and very light and scattered fellings, or else more concentrated fellings with the danger of reducing the height of the shelter strips.

The regulation of rights in forests open to grazing may offer difficulties.

As regards the collection of seed, it would be interesting to compare germination tests with seed collected for the experimental plots, with the care usually bestowed on this work, with seeds collected by coolies, and brought, say six miles in a June sun. This lead is quite enough, very often, to make Sal seeds in a sack ferment to such an extent that the germinating power is materially reduced.

PART II.

Mr. Hole's system for Sal regeneration marks a very long step forward on anything that has gone before, in that he shows, as far as experimental evidence can show, that by means of it the average Sal forest of Northern India can be regenerated in a short period with reasonable certainty. He argues that it is not a good thing to regenerate Sal forests under shade, as nature does, on account of the very long regeneration period required, due to the small percentage of seedlings which establish themselves, and the very long time taken by a seedling to attain the necessary height of 3½ feet before the overwood can be removed : and it is possibly here that his critics will join issue with him. The fifty year period required is based on the rates of growth of observed seedlings of known age growing under shade in experimental plots, the first results from which were obtained in 1912, probably after three or four years' experimenting, so that the experiments will now be about ten years old. But ten years is only one-fifth of the period claimed to be necessary, and no evidence is adduced in the article in question to show that the rate of growth is constant and comparable to that of the first ten years, during the remaining

forty years of the period; nor that the removal of the cover, say after 25 years, will react on the seedlings in the same way as the removal of the cover after ten years. In the article quoted little reference is made to the phenomenon of dying back which is so constantly observed with Sal seedlings in a natural state. Troup however [note on European sylvicultural systems, p 70] mentions, with reference to these experiments, that Sal seedlings have been obtained, *which have not died back* (the italics are his) and the inference is that the rates of growth quoted, apply to seedlings which have not died back. It seems very probable that in nature the average exploitable Sal tree died back several times before establishing itself, and the question now arises whether it would not be worth while to adopt a Shavian Paradox as a basis of further experiments, and instead of finding out how to prevent the Sal dying back, find out, so to speak, how to make it die back.

In the average Sal forest of Northern India as at present constituted, the average Sal seedling probably lives on for a number of years, dying back periodically, but all the while storing up more and more food material in its roots, or at any rate building up a big root system out of all proportion to the above ground shoot, until a fortuitous combination of circumstances gives it its chance to go through, when it shoots ahead with amazing rapidity, and, for a few years, may even put on three and four feet in height growth a year. Such Sal seedlings are a common sight in any of the submontane forests of the U P., and overhead clearance is probably what gives it its chance as much as anything else. The rate the Sal shoots up in the cleared areas, under the Gorakhpur system, is well known, and *always barring the frost danger*, it would probably do so elsewhere as well. Near Nishangarha in Bahraich it is, in many places, doing so where clearances have been made. It is quite a feature of the good type of forest near Chandanpur in Gonda. It is quite commonly doing so in the cleared areas of Periodic Block I at Thano in the Dehra Dun; whilst it is a marked feature of the Group "A" fellings in the "conversion to Uniform" circle in

Ramnagar, both near Hathigaliar and in the Kumeria Block. Here the overhead cover was lightened, 40 to 50 per cent. of the trees being removed, roughly in groups with the idea of helping existing regeneration and obtaining more Last year's seed year gave practically no regeneration on these areas at all, although it gave much in group "B" under shade, but the regeneration which existed there previously has made an extraordinary response. In fact the clearance has stimulated the Sal to that sudden upward rush mentioned before.

We cannot, however, make complete clearances over this area because of frost. It is, however, at least possible that some system of strip fellings over already established regeneration, which has been dying back for some years under shade, might provide a solution. The shelter strips being very narrow, so that they could be removed before the surrounding young stuff has attained a great height, just sufficient to protect a very narrow strip from frost.

We would then have to find out the factors governing this wonderful spurt the Sal makes after dying back for some while, and endeavour to reproduce those factors. Could we do so, reducing frost, and giving the seedlings the most favourable light conditions, by means of some form of strip fellings, regenerating our failures by Hole's method, we have practically overcome the labour and supervision difficulties, as well as the sylvicultural difficulties mentioned in Part I of this article. At least there is only the weeding left, and once the Sal starts going ahead, that is not too heavy a matter.

It may be argued that this does not reduce the regeneration period from fifty years to fifteen, but in reality it does. We can commence regenerating under full shade, fifty years before the crop is due to move into Periodic Block I if necessary, and if when that crop enters Periodic Block I and we remove our trees at the age of maturity we can make our regeneration go straight ahead, we have in reality reduced the regeneration period. What we have to do then is to remove the old crop in such a way as to obviate frost damage and cause the Sal regeneration to shoot ahead

My suggestion then is that we should now find out, by experiment, the factors governing this upward rush of the Sal, which has been dying back periodically under shade, so that we can remove an old crop in such a way that, in areas where frost is a factor, we can still get the Sal to go ahead undamaged, and this, probably, by removing the overwood in strips; but with as great certainty as it now goes ahead in Gorakhpur, after clearances in areas where there is no frost. And if the fires of controversy can fine down these suggestions to something which can be tried experimentally, my Easter Bank Holiday will not have been as sadly wasted as I feared this morning it might be.

B. R. WOOD.

Note.—This article reached us just as the Forest Botanist was about to depart from Dehra on furlough and there was not time to obtain a reply to Mr. Wood's criticism. Mr. Hole, however, left notes on the main points as follows:—

"*Labour.*—Owing to the advance growth now more or less existing in practically all our forests it is probable that, on an average, only about ¼ to ½ the total area will have to be actually hoed and sown. If labour proves so great a difficulty as Mr. Wood anticipates, there is no reason why we should not continue to get this advance growth by judicious burning. It is also probable that the establishment of advance growth will be assisted by the side-light given to the unworked strips when the alternate strips are felled.

Apart from this, however, I feel sure we ought to do more by organizing permanent labour corps similar to those found so useful in grass work.

Inspection.—This has certainly been overstated. One of the reasons for constant inspection by the D. F. O. now is that the work has not yet become of a sufficiently routine nature to allow of its being entrusted to subordinates. Judging from the broadcast sowings at Lachiwala, one inspection annually by the D. F. O. should be enough.

Extraction.—There is no necessity for the export roads to keep strictly to the strips, while confining the fellings to definite

strips must make extraction easier than in the selection, group or compartment systems.

Width of strips should be calculated on height of forest at half the rotation, thus: -

Rotation 150 years

Height at 75 years = 80′

Width of strips—¾ of 80 = 60′.

The alternate strips would then be regenerated when the original strips are 80′ high, *i.e.*, 75 years old.

This has been explained in the Forest Record now in the Press.

Sacrifice.—During the first rotation all promising pole crops would be kept. The alternate strips would be managed under light improvement-*cum*-selection fellings (as is being done at present) until they are regenerated. Such fellings would not reduce the average height of the forest below 80′.

Mr. Wood finally suggests that the factor responsible for dying back should be investigated—all our experiments indicate that it is primarily unsuitable conditions of soil aeration and moisture which can be improved by suitable fellings."

[In our opinion, there are also important considerations which the author of the system has not dealt with as regards the effect on the growth of the young Sal located at the edges of the narrow strips. It would seem natural to suppose that the portion of the young crop situated in the centre of the strips would eventually get well ahead of that growing at the sides. Would it be necessary to wait until the edge trees had reached a height of 60 ft. before commencing operations on the remaining strips? The system would appear to retard the growth of the regeneration at the edges of the strip and would perhaps result in a very uneven rate of height growth. The quantity of seed to be collected in order to deal with even a quarter or half of the area under regeneration is also very large; and as may happen when the seed crop fails completely, difficulties may arise in making up arrears. We hope to find all these objections fully traversed in the monograph recently completed by Mr. Hole and which we hope to see published shortly.—HON. ED.

RESERVATION OF STANDARDS IN STRIPS AND CHECKS IN EXPLOITATION.

In the Bombay Presidency, the general method of reserving and numbering standards in areas worked under the coppice-with-standards system seems hitherto to have been by groups more or less scattered through the coupe. Hence great difficulty was experienced when checking standards during the working or at the expiration of a contract. Sometimes, it used to take half an hour to check some 10 standards. It is, therefore, obvious that all the standards in a coupe were rarely checked before charge of the coupe was taken back from a contractor, and the Ranger had, by force of circumstances, to sign a false certificate of checking, for in one year's coupes he might easily have 30,000 standards. Under these circumstances, reservation in parallel strips was adopted. The writer does not lay claim to be the originator of the idea, but merely takes this opportunity of describing how it is worked out in the North Khandesh Division.

2. First of all, the reserving officer marks the necessary standards in a strip 33' wide round the coupe, starting at any convenient point, say, at cairn No. 1 (see sketch map below) putting on tar bands at breast-height, and writing serial numbers with tar on shal-blazes so as to face him as he goes forward; then he takes in hand a strip approximately 33' wide parallel to any side; and when he has finished this strip, he returns in the opposite direction reserving the standards in the next strip about 33' wide and parallel to the strip just finished. In this way he proceeds through the coupe, the numbers in alternate strips facing in opposite directions. In practice this method of reserving standards in parallel strips is found to take no more time than by groups, as the whole area has to be walked over whichever manner is adopted; and an advantage is that standards are almost automatically evenly distributed.

3. When filling up the register of standards, the marking officer makes a note as to the exact position of the number of

the tree which begins and ends any one strip, *e.g.*, "opposite standard No. X in the first boundary strip"; hence, if an inspecting officer wishes to check any specified tree he knows exactly in which strip to look for it; and since the numbers in each strip are all written so as face one way and go in serial order as one proceeds forward in the strip, the officer can soon come across the exact location of the tree looked for. When in the right strip, and looking for a special number he does not trouble to look to the right or left at trees which show only tar bands facing him, for he knows that their numbers must be on the opposite sides of the trees and that they are therefore in the next strip. In this way he knows that a given tree must be within the limits of its strip and between its backward and forward serial number. Under this system, it is easy to check 200 standards in an hour.

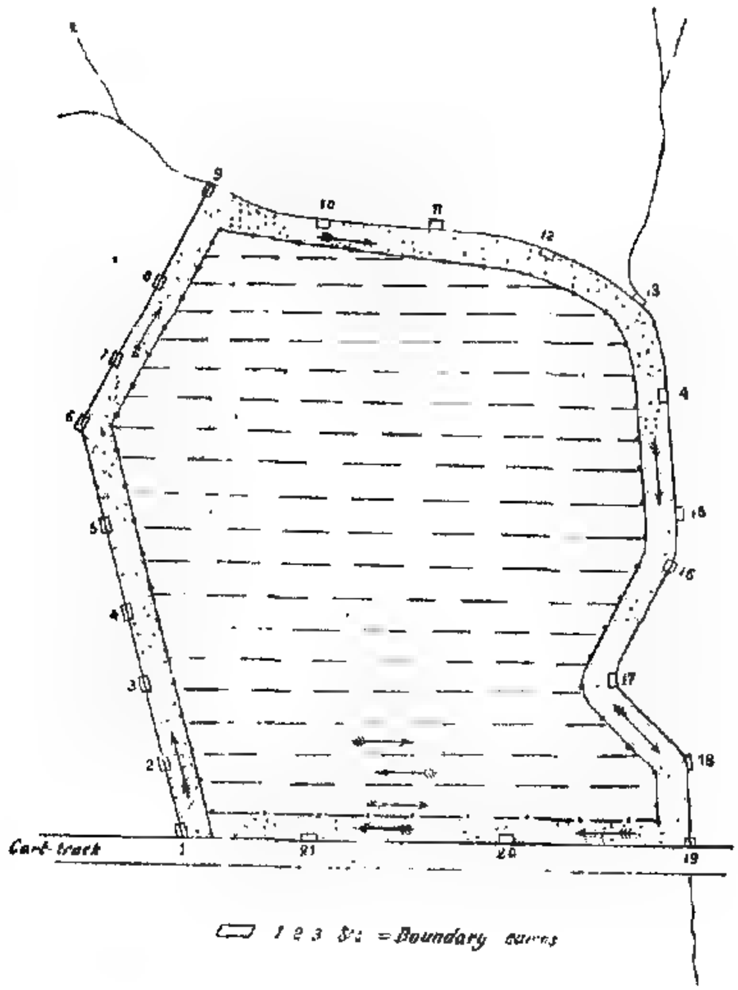
4. If the terrain of the coupe is very hilly, the area may be divided up into suitable blocks, and the strips in each taken more or less parallel to the contours.

5. As a safeguard against illicit felling of standards by contractors, special guards are detailed to supervise the work daily in the more valuable coupes, and the contractor is made to comply with the following procedure:—When a tree is felled, it may not be squared or removed until it has been checked by the special guard, and the butt-end and the stump have been impressed with his marking hammer as a token that the felled tree is not a reserved standard and is passed. Further, no material under 24" in girth is allowed to be barked in the coupe. If the special beat guard connives at the felling of a standard, he and the contractor alone will be held responsible when the theft is discovered on finally checking the reserves.

6. Since the introduction of this system of reservation of standards in parallel strips, frauds have, on several occasions, been brought to light. It has had a markedly restraining influence on contractors who cast covetous eyes on valuable standards.

7. When the price of tin becomes lower, small serially numbered tin plates may be nailed to the standards instead of writing the numbers in tar on blazes. If such tin plates are nailed to the

standards, the nails should not be driven home, otherwise the tin plates are forced off over the heads of the nails, because of growth in thickness of the trees.



H. W. STARTE,
Divisional Forest Officer,
North Khandesh.

5*th April* 1919.

SOME KHEDDAH INCIDENTS

Elephants are captured by two methods in Assam, either by chasing herds and noosing calves, called *mela shikar*, or by driving into stockades, called *kheddah shikar*.

The former method, though far less productive, is the favourite amongst Indians because it involves no initial expenditure beyond the purchase price of the Mahal, and also because anybody, who catches an elephant, gains a great reputation as a *phandi* (nooser). One is inclined to have visions of elephants dashing through the forest until some well-thrown lasso brings up a calf all standing, much like a roped steer in the wild and woolly West, but there is actually nothing romantic about *mela shikar* except the fact that it is commonly practised on moonlight nights. The rope used is so heavy and the noose or phand has to be so large, that it is impossible to catch a moving object, and the noose has to be dumped down on the back of an elephant's neck in the hope that it will curl up its trunk and allow the noose to be pulled tight. Elephants will, time after time, remove the phand with their trunks and this is especially the case with young tuskers, who are provokingly cunning. An effort is generally made to creep into a scattered and feeding herd and then to pick out some youngster for roping, but if the herd is scared and moves off, it is necessary to pursue until a calf gets behind and can be cut off. Such a calf will often quieten down and stay with the koonkies until roped. The *phandi* sits on the koonkie's neck in the mahout's seat, and behind him there is another man, whose duty it is to get unwonted pace out of the koonkie by prodding it at the root of the tail with the point of a dao, and who also helps in shortening the rope after an animal has been noosed. The noose is tied with a piece of cord to prevent it slipping up too tight, but this can only be done when the captured animal takes a breather after the first desperate struggle, and if it has managed meanwhile to get round a tree, death by strangulation commonly follows.

The Forest Department, however, had a serious objection to *mela shikar*, because it was found that the *phandis* used their spare time in shooting deer and selling the flesh, while the bolder

spirits even went after tuskers and rhino. It is obvious that there can be no efficient control over these men, who are provided with elephants and guns, and can wander where they like in their particular Mahals. Personally, I have known of four cases of *phandis* shooting tuskers. In one case the elephant travelled a long way before dying, and the *phandi* tracked up the beast only to find that a number of tea-garden coolies had found the carcase first, and were prepared to settle his claim to the tusks with their axes. This must have been very bitter, but he could get no satisfaction. Information was given in another case that a *phandi* was going to take a pair of tusks by night to the local Kayah's shop, so the D. F. O. spent the night hiding close by, but nothing happened. When he got back to his bungalow, however, early in the morning, he saw a pair of tusks lying in his verandah. The ruffian, who had brought them, turned up later with a smirking countenance and said he had found them in the forest, and wanted the usual 12½ per cent. reward for bringing them in. Both the remaining cases relate to one man, who spread the report that there was a very big tusker in the Mahal going about killing other male elephants. He brought in two pairs of tusks and was paid the reward for them, but his little game was spoilt by some one finding one of the carcases with a bullet in the head and giving the show away. There must, of course, be any number of cases which never come to light.

A dead rhino, in the same way, is more profitable to a *phandi* than many months of hunting elephants. The horn can be sold readily for a large sum, while the dried flesh and skin are also valuable. A man could get anything from Rs. 200 to Rs. 400 for the various parts of a rhino.

This sort of thing could not be tolerated in a Game Sanctuary or Reserve Forest, so the Local Government, at the Department's request, embarked upon a scheme for hunting the Province systematically by *kheddah shikar* alone. The Mahals are, however, being so thoroughly worked under this system that their exhaustion is within sight, and steps will have to be taken to preserve the breeding stock, or there will be no elephants left to hunt. It might be found feasible to allow *mela shikar* from time

to time in the Khas and some of the Reserves, while the Game Sanctuaries and remaining Reserves are specially kept for Government Kheddahs for the supply of the necessary big elephants

An equally cogent reason for the suppression of general Kheddahs is that it is found that it has led to terrible cruelty being perpetrated upon the elephants in some of the Indian-owned Mahals. The trouble is that small elephants are more valuable, when first caught, than big females, unless these be of very particular build. A female or tusker calf about 6 ft. high will sell for Rs. 1,500, if possessing the correct number of white toe-nails (18) and a full tail, but a big female will only fetch about Rs 1,200 or possibly Rs. 1,400. These figures refer only to *untrained animals* *The reason for this is not far to seek.* There is a great demand for elephants, other than mucknas, in other parts of India, and the railways will carry animals that are not over about 6′ 6″, so that any trader, buying only small elephants, can rail them to his market expeditiously, instead of having to march them, while still soft, for several weeks along the Trunk Roads, with all the difficulty and expense of procuring adequate and suitable fodder. Again, it is obviously much easier to handle and train the youngsters, two of which can be controlled by one koonkie, whereas a larger elephant may require two koonkies to itself alone. Small elephants, too, do not put up such a fight, so that the danger of death from bad rope-galls is very considerably less It may, therefore, pay a Mahaldar to scrap the big elephants, which he stockades, and remove his koonkies to deal with other catches as soon as possible. A Purneah trader will be managing and feeding all the small elephants, which he has purchased, without the help of a koonkie 10 days after an auction sale, but a bigger elephant requires the use of a koonkie for training, and especially for bringing in grass, for a longer period than this The Mahaldar is bound to lend his koonkies to the purchasers of the wild elephants until they can go by themselves, so that *anyone*, who buys a big elephant, is very much in the hands of the Mahaldar and he is very much in the hands of his men. They are not particularly interested as to the fate of the animals, and the temptation is to adopt the most violent

methods of training, so that the elephants are finished with, one way or the other, as soon as possible, and the koonkies freed for other work. A common device with such men is to cut a slit across the back of the neck of any elephant, which shows much fight. The neck rope, or phand, is made to fit into this, and then the animal can only struggle at the risk of enduring most frightful pain. Septicaemia is the common form of death, arising from the rope-galls on neck and legs, and the large numbers of punctures from spear-thrusts. The elephant is very often slow to die and may not succumb for two or three months to the punishment it has undergone. There is no mercy, of course, for elephants that have just calved, or are about to calve; they have got to go through it just the same. Mahals differ, naturally, very much according to the Mahaldar, and these things do not go on under European supervision, but prevention is better than cure, and by only allowing *mela shikar* such abominations will be largely curtailed. Omelettes cannot be made without breaking eggs and a certain proportion of mortality is bound to occur even amongst the calves caught by *mela shikar*

When the Kamrup Mahals with those in the Khasia Hills came up for sale for two seasons in the spring of 1917, the Forest Department retained for itself a compact block of Reserve Forests, because the area was known to be a regular elephant breeding ground, so that, by stopping operations here, overhunting elsewhere could be, to some extent, counter-balanced, and also because there were certain prescriptions of the Working Plan to be carried out to which an outsider might object as interfering with the hunting.

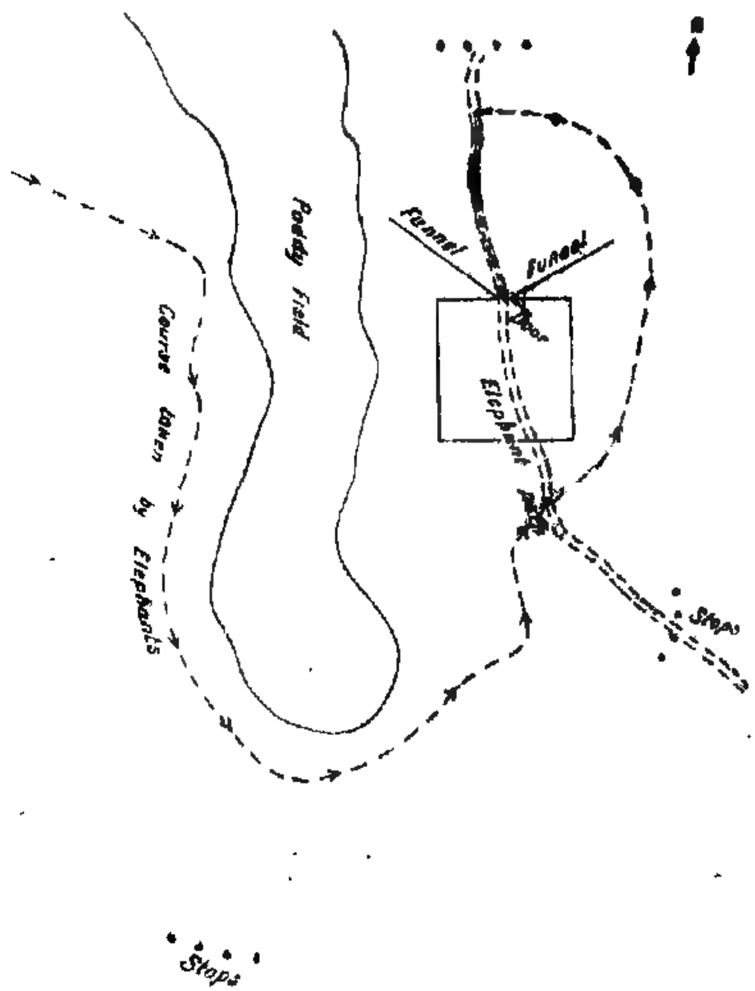
The Forest Department caught 40 elephants between December 21st and the middle of February, the next Mahal and the neighbouring Khasia Hills caught 78 between August and the end of March, while 49 elephants were taken in the third Kamrup Mahal and adjacent Khasia Hills. Quite a considerable number were caught elsewhere in the Khasia Hills too.

There still seemed to be a fair number of herds about, but to be on the safe side we determined to release all the dhuis (breeding females), which were caught in the Government Mahal

during 1918-19 and so not reduce the breeding stock more than we could help.

We commenced operations this season on November 29th, when an exceptionally large herd of 50 or 60 elephants were reported near the Borbakra Stockade. The drive failed on account of a new-born calf, whose mother kept charging back, and of a big tusker, which chased the drivers.

A rough diagram, not drawn to scale, will help to elucidate the following day's operations.



The stockade is built across an elephant path to the east of a long narrow finger-shaped stretch of paddy land.

I told the man who as co-partner had to build and pay for this stockade, to put in two gates, but I found afterwards that he had only put one in, on the north. When I asked him why, he said he did not see how it would be possible to catch elephants if there were two gates, as the elephants would go in at one and out at the other. I explained to him that anyone less of a pudding head would have understood that the door farther from the herd would have to be closed before the driving commenced.

The Borbakra people were rather down in the mouth about this time owing to a number of deaths from influenza, so I told them all early in the morning on the 30th that this was a lucky day, because elsewhere in Assam the Peace Celebrations were being held. All sorts of forest guards and mahouts had to be called upon to help in the driving in order to make up the numbers necessary for the 'zubberdust' operation we contemplated, namely, bringing the herd across just beyond the south end of the paddy-field, then north past the stockade and back again south along the proper elephant path. If the paddy had been cut, the elephants would have been out at night to eat the straw, and driving would have been much simplified; also, obviously, if there had been a southern door to the stockade.

The drivers went off about 9 A.M. and I sat with the other door men on the edge of the paddy-field (called "pathar" in Assam), near the end of the funnel. The first we heard of the drive was the cracking of some bamboos just across the other side of the "pathar," and soon afterwards we heard the tap-tap of a dao on a tree. As little noise as possible is employed in driving elephants, provided they are going right, because they are inclined to panic and break away in different directions, if much frightened. Guns and shouting have to be employed when the herd is heading the wrong way and trying to get out of the drive, in the hope that it will turn back and proceed as desired. We got up into the 'machans' now, and it was not long before the excitement began. The elephants were extremely averse to crossing at

the end of the "pathar" and broke back a number of times. There were various parties acting as stops, and they had a busy time, as the big herd began to dissolve into its component parts or families, and the different bands sought to escape towards some favourite ground to the south west. The stops managed to get in front of a herd of about 15, which were driven back by a gunshot and returned to the bamboos on the wrong side of the "pathar." The drivers got round behind them again, and the whole force of beaters was concentrated on this lot, which was absolutely compelled to take the course it objected to. There is a piece of ponky (marshy) land between the end of the "pathar" and the stockade with enough cane to discourage a human from trying to get through, and the first intimation we at the stockade had of the elephants was the sound of them coming through the ponk. There were stops on a hill to the south-east, but they had nothing to do, and the elephants turned northwards of their own accord. There are some bamboos growing near the south-east corner of the stockade, and it was quite exciting seeing these being bent to one side as the herd forced its way through.

Once clear of the bamboos the elephants came into sight. They were now not more than 30 yards from the gate machan, in which I was squatting, and being on the side of a steep hill the animals were, if anything, a little above our level, a truly impressive sight at such short range. We, of course, were lying very low, but it seemed ridiculous that they did not spot us. Something went wrong after the herd had got round the end of the funnel, and about eight broke away up the steep hill to the east, the remainder going straight on north. These had to be turned by the stops, and there was a most exciting pause between hearing the shouts of the stops die down and the arrival of the elephants at the stockade the stops must have been about 400 yards away. Disaster was nearly occasioned by one of the amateur beaters, whose enthusiasm took him, though very far behind in the hunt, through the ponk and cane, so that he was passing the end of the stockade, uttering hoarse cries, just at the time that the elephants were coming along to enter it; however, some one

managed to scrag him before it was too late. A batch of drivers should have come across from the other side of the "pathar," but the information was not passed along properly, and no one came to press the elephants over their last lap. The consequence was that they straggled in first came three calves and two dhuis in a great hurry. They entered without any demur and did not halt until the ditch and palisade at the other end of the stockade brought them up. They remained for some moments cogitating on these phenomena, and then turned slowly to reconnoitre the position Nothing else being in sight, the door had to be shut as they approached it. It had just banged to, when a dhui and a calf arrived post haste, and the man, whose duty it was to secure the gate, having bungled his job (luckily for us), the dhui barged it open and entered the stockade with her calf. One of the big dhuis inside had, at that moment, got a run on and, as the new arrivals scraped their way in round the end of the gate, she landed right in the centre of it, and banged it shut with a crash that must have afforded her the greatest satisfaction. The gate was now fastened, but quite a minute later a fine young tusker, about 6' 6", turned up, seeking an entry, which unfortunately we had to deny him. We sent a couple of koonkies with phands after him, but he got away in the gathering darkness. The catch consisted of one stand-out dhui, one old dhui and a dhui, which showed rope marks on her legs. Of the four calves two were tuskers and two mucknas. A big tusker rolled up when it was really beginning to get dark, and I had, with the greatest possible reluctance, I must confess, to take my rifle and go after him. It was too dark to see anything *more than his huge bulk, and as he sauntered off of his own* accord, it was unnecessary to fire at him. He did return during the night and was fired at from the stockade.

The koonkies had no difficulty next morning in dealing with the run-away, which we took over for Government, and the four calves. The two remaining dhuis were released, being driven out of the stockade in front of the koonkies. There were 50 or 60 people looking on at the tamasha, and I kept these back for a

few minutes in order to let the koonkies get on a little distance. When we did start after them, we found that the two released dhuis were very close to us in the thick jungle, uncertain, apparently, whether or not they ought to follow their bellowing calves. We waited a moment or two, just to make sure, and then started off again along the path. My bearer, who was next behind me, having ascertained that there was no danger promptly turned round and shouted to my sweeper "Jemadar, ut, ut," whereupon a still small voice from the highest machan in the middle of the paddy protested that he had "uted" as high as he was able, and could "ut" no more. The multitude was much pleased at the joke. I should explain that the other servants consistently work on the feelings of the poor sweeper, who is no denizen of the jungle by choice. They told him that there were a lot of tigers at this place, and whenever a civet cat came round the camp at night, they always called it a "bagh," the occasional roaring of tigers in the distance lending some substance to their statements; at any rate the sweeper never emerges to verify the "baghs." He retires to his tent at dusk with a lantern and a great heap of fire-wood, and, at his own request, with the cook's murghis for company. He is said not to sleep at all during the night, and I must say he responded very quickly to my warning when, some weeks later, I rolled out at 2 A.M. to find a tusker eating stubble 80 yards from my tent.

We marched the elephants that very morning to a pil-khana near Kulsi, a Range Head quarters and the site of our principal Forest Inspection Bungalow. We were greeted there with the news that elephants had been heard at night in a direction favourable for driving to our Tiyamara stockade, so I took a few men, and went to the stockade to make sure that everything was all right. It was lucky we did go there, as we found that the gate post of the south door had got out of the straight and that the end of the gate was resting on the ground. We fixed this up, and then shut the gate in order to tighten up the natural spring which we use for closing the door after the elephants are in. This consists of a long piece of cane tied to the top of a

stout sapling, the top of which is bent over by hauling on the cane: the free end of the cane is tied to the gate, and if this has then to be forced open the sapling is bent down still further. A thin piece of cane leading to a machan keeps the gate open, and one cut with a dao severs it and allows the spring to come into action.

I was up before dawn next day and away to turn out the beaters, who do not like early hours in the cold weather. The men, who had been watching the herd at night, reported that it was quite close to the south door of the stockade, and contained about 30 animals. The Tiyamara stockade is built across an elephant path high up on the north face of a hill in a little cup, with a steep hill behind, and hills on each side, to the east and west, that might be called mildly precipitous. One would need one hand free, at least, if one was going to walk along their face. To the north the path leads steeply downhill. The herd had spent the night in the Bil to the south, and on the far side of the hill.

The beaters went off about 9 A.M., while we, who were to man the machans, went up to the stockade and got to work. First of all we had to close the north door securely, and then we had to cut green shrubs and thoroughly camouflage the stockade, the funnels and the entrance generally. This had all been done before, but the leaves had died and it was advisable to have a little green about the place. The gate itself and one gatepost had been tastefully hidden with a fat-leaved orchid, which is common here, and needed no further decoration, and the post on to which the door was to shut, was a living Sal tree. As we had not previously caught elephants in this stockade, there was quite a fair lot of jungle growing inside naturally, and we had nothing more to do than dig a few holes with our daos and stick in shrubs. The far gate took us some time as the builders had forgotten to camouflage it on the inside, and now that it was shut, it was very visible. However we had finished it and put the necessary finishing touches to the funnels and the approach by 11, and we then got up into the machans. My duty was to secure the

gate; they had forgotten to build a machan this side of the gate, but I had quite a comfy seat on the palisade leaning up against the Sal tree, and I rigged up a screen of branches, so that I would not be immediately visible to the elephants when they had reached the far gate and turned round to consider the situation. We had a long and weary wait, and it began to feel very chilly after the hill to the west had shut out the sun about 3 o'clock, but we were rewarded by hearing faint shouts soon after 5, and shortly afterwards Boom! went the muzzle-loader, stationed about 400 yards from the stockade entrance and fired after the herd has passed to ginger up the laggards. I must pause at this breathless moment to explain that at the ends of the funnels (the functions of which are obvious) are two machans, in which dependable men are stationed to prevent the elephants from working away from the mouth of the stockade and escaping round the ends of the funnels. It is important that these men should know when to make a noise and when to remain silent. Elephants came over the skyline a few minutes after the report of the gun, 7 of them, 2 being dhuis and 5 being calves and half-grown beasts. They were up on the side of the hill to the east of the proper path, and their course would have taken them round the end of the eastern funnel but for the stop in the machan tok-toking his bamboo instrument at the right moment precisely. If he had done it sooner there would have been time for the elephants to stop and alter their course still more up the hill, if he had waited longer it might have been too late, and the elephants might have barged on and escaped. The hill, down and along which the elephants were coming, was so steep, that the leading dhui was on a level with the machan, when the man made his demonstration, and she spotted him. She charged down and smashed up the supports to the machan (luckily it rested principally in the fork of a tree), but was afraid to continue her course and turned and came down towards the mouth of the stockade. I thought she was going to bring her companions in for certain, but she crossed the path at right angles and began to climb the hill to the west, following up the funnel on that side. Now was the time for the man there to make

his demonstration, but having seen what had happened on the other side of the stockade his bowels had turned to water and he never made a sound. The elephants solemnly climbed up, found the end of the funnel, forced their way through some bamboos growing there, and passed slowly along the west side of the stockade, only 15 or 20 yards away.

Meanwhile another batch of four elephants came along, also up the hill to the east. The funnel man turned these too, and they came at a great pace down the hill and into the stockade. The catch consisted of two dhuis and a tusker and a female calf, which was rather disappointing. It is fairly certain that the unlucky accident of the stop being spotted by the leading lot of elephants caused that part of the herd to break away to the west, instead of entering the stockade. Herd elephants panic very easily, and for that reason the funnel stops do not shout or make any great noise. They are usually provided with a bamboo clapper, which they use with caution. It not infrequently happens that the driven herd comes along far ahead of the beaters, and slightly off the proper course. The funnel man concerned then gives two or three faint tok-toks with the clappers and the elephants at once stop. The sound is unfamiliar to them, so they are frightened to go on in that direction, but at the same time they have heard nothing to make them believe a man is in front of them, and they just decide to make a little detour and avoid the vicinity of this curious noise, that might mean danger, though not loud or aggressive, like man: the detour, of course, lands them in the stockade.

The Tiyamara stockade could not be built as strongly as desirable on account of the underlying rock, and with so few animals inside there was plenty of room for the bigger dhui to charge freely and give us all the anxiety we wanted.

The son of one of the co-partners in this stockade had never seen a kheddah before, but he learnt a great deal about the subject in a very short space of time, as the big dhui's first charge was against the part of the palisade, where he had stationed himself, and she sent him flying off. Our koonkies were at hand and we thought that there might be enough time before darkness

to rope the two calves, so we called the *phandis* up to the south entrance and prepared to admit them. The south gate is well hung for shutting, but is a little troublesome to open. There was no rope fixed on to it for anyone to haul on to from the side of the stockade, so the leading koonkie had to shove it open by himself. He had got it about half open, when the dhai came full-tilt at it and shut it slap in his face, knocking him backwards a few yards, and we then decided to wait for daylight next morning and arrange to open the gate more expeditiously.

The old-fashioned stockade consisted of a number of stout uprights, well buried in the ground, with logs placed horizontally in between the uprights to make a solid wall, but this was an expensive form of construction, and it has been found that a much more lightly-built stockade can be made to suffice, if scientifically constructed.

Posts, 17 to 18 ft. long and 6 inches in diameter, are buried 5 ft. in the ground at intervals of 4 or 5 ft. Three rows of horizontal posts are tied to these on the outside, one row at the bottom, one in the middle and one near the top, and there are plentiful struts to support the middle and upper rows. The filling-in consists of green posts, about 3 inches in diameter, placed vertically with their bottom ends resting on the ground and not buried. These posts are tied with cane on to the three rows of horizontals, and as it is desirable that the elephants should be able to see through the stockade, the posts are placed not quite touching one another. There is a great deal of give in this form of wall, but it is difficult to smash. Men are stationed outside to poke at any charging elephant, with sharpened bamboos, while fires are lighted all round at night. A deep ditch is dug inside the stockade to prevent the elephants from being able to hurl their full weight against the wall, and they lose most of their momentum in having to pull up and stride across the ditch. It is found that elephants (at any rate herd elephants) will not charge with great conviction, if they can see a man standing, armed with a spear, on the ground outside, and for this reason it is a good thing to leave sufficient space between the upright poles. The door is obviously especially

liable to attack because it is unprotected by a ditch, and also because the elephants recognize that it is barring the very piece of ground along which their path runs, but the elephants are kept off by the very simple expedient of tying small poles on to the door so close that the animals cannot see through it; they imagine that this must be the most solid and substantial part of the whole erection and do not go for it, as used to happen, before some wily person thought of this simple piece of camouflage.

I was just preparing to leave, when two of my servants arrived with considerably shaken nerves. They had heard that elephants had been caught and thinking that I might like some tea, they had started for the stockade, taking a short path along the face of the hill, which we had cut for ourselves in order to be able to approach the stockade without using the elephant track.

It appears that the seven elephants, which got away past the side of the stockade hung about amongst the bamboos and rocks high up on the side of the hill until it was quite dusk, when they slid down, crossing our short cut a few moments before my servants came along, so that they very nearly met: as it was, they passed within a few feet of each other, and both got a good fright. These same seven elephants retraced their steps in the night, and passed quite close to the stockade despite the noise and the fires.

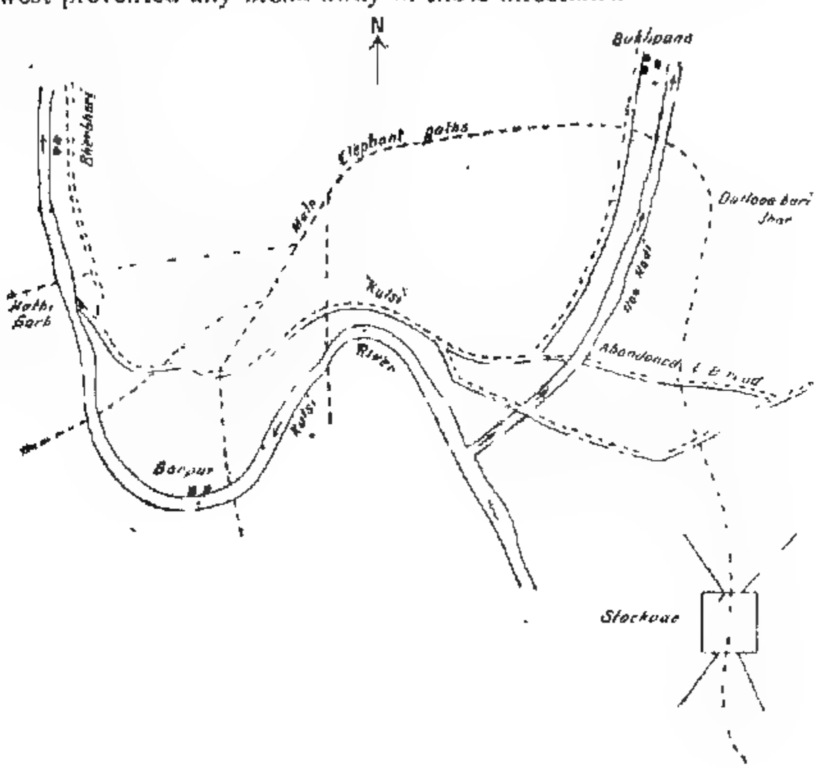
Orders were given for the koonkies to be ready early next morning and I started off about 7 o'clock myself. I had to pass our pilkhana on the way, and I was horrified to notice a most distinct swelling under the tail of the run away elephant, which we had taken over from the Borbakra stockade I called out all our elephant men, and we had a great headshaking and prophesying of a bad time. I must explain that this elephant had allowed herself to be prodded rather badly by a small tusker, caught at the same time as herself; we had experience of this sort of thing last year and feared that she had been injured badly and would require a lot of doctoring. We made up our minds to tie her up fore and aft in the evening and see what could be done.

There was no trouble with the elephants at the stockade. We roped the two calves and drove the two dhuis out of the south gate up the hill, down which they had come the day before. They

went away very slowly and majestically, stopping and turning round every now and then and bellowing, but I have no doubt that they legged it, as soon as they were over the crest of the hill and found that they were free and alone. It was a fine sight, seeing the great beasts stalking away so defiantly. We then returned in some depression to the pilkhana, having every anticipation of a month or two's doctoring a sick hathi morning and evening, a job we have unfortunately had to do too often in the past. I could hardly believe my eyes, then, when I discovered that the elephant had given birth to a calf during our two hours' absence at the stockade and the relief to us all was immense. It is an odd thing that an elephant shows very little outward sign, when carrying a calf, and we could see no difference in the size of the mother since she had given birth. This animal had quite a small calf at foot, when captured, and no one had suspected that she could be due to calve so soon again. Dhuis with biggish young ones at foot are certain to be heavy with calf, and so are immature females, whose teats are enlarged, but who have no calf running with them. The mother of the new arrival had been christened "Peace," as she was caught on November 30th, the day which Assam observed with festivity, and there did not seem to be any alternative but to name the youngster "Plenty." It had taxed one's command of the vernacular to explain exactly the appropriateness of the name Peace, but there was no corresponding difficulty about Plenty, which could be explained as the approaching time, when dhotis would be cheap and shop-keepers would give 16 annas for a one-rupee note instead of only 14, the millennium, in fact. I have forgotten to mention that during the last drive a man caught a very young calf, which had been abandoned by its mother. He brought it in after dark. I ordered it to be taken away and fed artificially. It lived a few days and then died of indigestion, as usually happens, and I have since blamed myself for not having put it up on the hill before we released the two dhuis, as it is just possible that they might have carried it off with them, though neither of them, we knew, owned it.

Our next bout of real excitement started on January 26th, when a herd was reported close by. We thought that it would

go in the direction of a stockade some miles to the south, if we blocked certain paths, and we were considerably astonished to learn that it had passed through the Tiyamara stockade very early on the 27th morning: both gates had been left open to let any wandering goonda through without affording him an excuse to break up the palisade. The D. C. was staying with me at the time and we both put in an artistic and busy morning camouflaging, while arrangements were being made for a drive. We thought that the herd might very well be driven back the way it had come as it had apparently passed through the stockade unalarmed. The alternative, that the animals had marked the stockade and vowed never to return that way again, also occurred to us. Having passed through the stockade, the herd would either have to follow the path round to Borpur village, as shown in the map, or return the way it had come, as cultivated land to the east, north and west prevented any break away in those directions.



The D. C. and I got up into the machan at about 3-30 p.m., while the drivers went out to try and drive the elephants towards the stockade from Dallooabari Jhar, where they were feeding. We heard gunshots and shouting not long before dark, and were in great hopes that everything was going smoothly, but we then had to endure a long and very tedious vigil until some men came with torches at 1-30 A.M., and told us that they had been unable to make the herd cross the abandoned Local Board Road. The elephants had been brought up to this without much trouble thrice, but had refused to cross and had broken back each time. We were exceedingly glad to be able to get down and go home to bed, as sleep had not been easy at the stockade. The machan was too small for us to sit in, and we had had to sit on the palisade itself with every prospect of falling off, if we dozed. The D. C. had found a position, in which he could wedge himself safely but with only one foot at a time, and he had dozed until the foot in use had gone to sleep, and then woken up and changed to the other foot. I had two safe positions in one sitting on a spike and in the other leaning back on to a spike and I had had to ring the changes accordingly. We sent the men off, after they had lighted us most of the way home, to watch the road to Buklipara and prevent the elephants from crossing, but they were unsuccessful in this and the herd crossed the road very early in the morning, scraping past Buklipara village There were only nine men and 2½ miles of road to be guarded, and the elephants were obviously determined to get away, and they avoided the fires along the road by sneaking across close to the village, where normally elephants do not venture.

Our next move obviously was to prevent them from crossing the road running west from Kulsi to the Kulsi River at Hathigorh, in the hopes that finding themselves unable to escape in that direction they would of their own accord retrace their steps and try to get through the Tiyamara stockade again. The news was accordingly sent out that we wanted men to keep the road at night, and about 150 had been collected by dark. These were distributed along the Kulsi Hathigorh road and also along the

path to Bherbheri village with instructions to light fires every 20 to 30 yards, and to make as much noise as they could all night long, a certain amount of liquor being supplied to loosen their tongues and keep everyone contented Guns were placed at the danger spots, while those in authority patrolled the road and saw that the stoking was satisfactory. The chain of fires, some 3½ miles long, made a most weird spectacle and the effect was quite beautiful where the road passed through a closely planted Teak Plantation, the stems and over-arching canopy of which looked like the pillars and roof of some cathedral, as the light from the fires rose and fell. The elephants made their first attempt to cross the road soon after 8, but they were repelled without difficulty. The herd contained a big muckna and an out-size in tuskers, and we had realized by this time that we were dealing with a herd, which had been stockaded in the Khasia Hills, but which had escaped owing to the tusker flattening down the palisade, so we had every reason to expect trouble. It was quite likely that the herd would break through in the face of the fires and the shouting if we let them get close enough undisturbed, and for this reason we made as loud and as continuous a noise as we could. The most efficacious weapon of the night was my 12 bore, from which I fired nearly 50 rounds in the course of my patrolling, choosing for each shot so far as was possible, a spot where some one had fallen asleep. The great disadvantage attached to the possession of the 12 bore was that its aid was invoked whenever danger threatened, and I had some prodigious runs to put in, firing from the hip as I ran, à la Hun, to encourage the defenders in their resistance. About 9 we sent a man to fetch our dinner, and a very jolly dinner it was, that we ate squatting in the road. There was, however, one small tragedy connected with it, in that despite the most careful instructions two bottles of Stout, my tipple, were brought, but no beer for the D. C., who cannot abide Stout We had just finished dinner, when an alarm arose and I had to run at top speed to the threatened point, that time a bitter disagreement arose between the Stout and the other constituents of my dinner; that is, I suppose, the

penalty of getting older, for one can remember a time when meals and furious exercise agreed very well. The elephants made a number of attacks about 11 o'clock and then no more was heard of them, and the D. C. and I had started off to the stockade at 1 30, when we heard a great noise on the road behind us, and we had to hurry back. An elephant had crept silently up to the road and was very nearly on it when its presence was detected in the firelight, and it had nearly managed to slip through before a fire-brand or two drove it back. We abandoned any idea of going to the stockade after this episode, as the elephants clearly had no intention of obliging us by going back in that direction. This was the last alarm and the rest of the night was spent dozing round the fires: the night was luckily cold and one kept on waking up as soon as the fire burned low. Once soon after dark and again just at dawn tigers crossed the road, close to fires and not apparently much put out.

We decided to try a drive by *force majeure* next day, as the herd was too cunning for ordinary methods, so we sent out about 80 men, in place of the original 9, and 3 koonkies. These latter were not much use, as they refused to approach the wild elephants and kept behind the beaters the whole time, and there is no doubt that they knew all about the big tusker with the herd. The D. C. and I were at the stockade by 4 in the afternoon with every intention of making ourselves comfortable on the enlarged machans, which we had built, but Fate was against us, and a downpour, as unexpected as it was unseasonable, commenced at half past 4 and kept on all night. Some of the drivers came for us at 9-30, with the news that the drive had failed owing to the two big elephants. The muckna had done nothing but charge all day, while the tusker kept walking round the herd and preventing it from bolting. The herd was in tree forest when the men came up with it, and the drive commenced favourably, but having got into a bil the animals refused to be forced out of it and they had to be left there. The rain prevented us from keeping the road as we had done the night before, and we heard next morning that the herd had crossed the river near Borpur before

we had got back to the bungalow from the stockade Every one was much disappointed except, probably, myself, for I was unable to see how I was to fulfill my rôle of destroying the big tusker, if the herd had entered the stockade after dark, and it was quite certain that he would have been through the stockade within 10 minutes, if not shot. Permission is always given to destroy large male elephants that are too big to tackle, and I have had to do it, but it is a horrible business. This particular tusker soon afterwards separated off from the herd and was able to spoil a drive for us at Borbakra. A herd came out to eat the paddy straw one night, and the men had sneaked up into the machans all ready for the drive, when his lordship arrived upon the scene. The herd bolted from him straight away and the men were unable to leave their machans while he was about. After feeding for a short time on the ' pathar," he wandered into the forest and discovered one of the wings of the stockade, with which he played spillikins. Then he either heard or smelt the men, and he had a happy time trying to pull them out of the machans at the gate, while they dodged him by going aloft up the Sal trees, on to which the machans were built. Generally speaking, large males are not found with the herds, or, if there do happen to be one or two, they are only too glad to break away and with masculine selfishness avoid all the trouble, and it is quite unusual to be confronted with goondas, who, like these two, stuck to the herd despite all the harrying they got.

The more one sees of kheddahs the more one is impressed with the fact that fear of man blinds the wild elephants to even the most obvious trap, and that experience teaches them little. Last year we caught a run-away, while two dhuis, which we set free were caught only a fortnight later in another stockade. We have taken another old run-away this season, and have recaptured an elephant, which we caught last year and which ran away just before the New Year. It is improbable that an animal would allow itself to be caught twice in the same stockade, but there does not seem to be much difficulty in re-catching run-aways, and they do not seem to be capable of warning others effectually.

Our fears that there might be too many elephants caught this year are likely to prove unfounded : the man, who caught 78 last year has only taken 8 this season with 6 weeks to run, while the man who caught 40, has only captured 1. The Forest Department has 26 to its credit out of which all the full and half-grown females with the exception of Peace have been released, 9 in all It might be supposed from these figures that there was indeed a shortage of elephants in the forests, but this is not the case. My neighbour, who caught the 78, has solely himself to blame this year, as he has quarrelled with his hunters and they have left him for the very good reason that he refused to give them any rice to live on, and so it is in the other Mahals. It would be an eye-opener to Mr. Montagu if he could spend a month in an elephant mahal, and realize how absolutely impossible it is for these sort of people to pull together as a team, even for their own mutual benefit. One mahaldar last year refused to disgorge any of the money he had received, so his men went to his house with daos and demanded their agreed-upon share or else his blood. He came out with a gun and said he would shoot them, but they did not mind, because, as they pointed out, he would not have time to shoot them all, so he had to cave in and pay up. This sort of behaviour does not inspire confidence, but is good for the hathis, because if the mahaldars and their employees did not squabble and cheat each other, and if they were to have a brain wave and spot the two first golden rules of elephant-catching, very few elephants would escape. Wild horses would not drag from me what the first two rules are. A large number of elephants have had the sense to seek refuge in a part of our forests where they are not usually found except casually, and consequently they are safe so long as they remain there, because it is too late now for anyone to start building stockades. One of my most experienced men saw a collection of elephants in that direction, which he reckoned contained 100 animals, and he is not likely to be more than 20 out in his calculation, as these people are really accurate in their estimates of the numbers composing herds Long may they stay in safety is our pious wish. The actual driving is an art, or should be. The Khapties from Upper Assam are our most

skilful exponents, as they work in teams and pull together. The Kulsi men, that is to say the picked men, are every bit as brave, needlessly brave to the point of stupidity, but they are undisciplined and need a leader. They know every inch of the country but their drives go wrong because they do not understand that the plan of campaign must be first worked out at home, and, as I have said, they have not grasped the first two simple golden rules. The work affords them much pleasurable exercise to which is attached the hope of gain so we let them be, as our object is not to catch so very many elephants. The principal obstacle to Europeans joining in the driving as at present managed is the difficulty of being nippy in boggy ground under the tall grass, but in an artistic drive, properly planned, there would be little danger to anyone accustomed to get through jungle at a reasonable pace. The stops are the most important people in the operations, and the stupidity and negligence of which they are capable, need to be seen to be realized. There can be no question but that catching elephants is a most exciting and pleasing occupation for anyone, who is interested in these sort of things and who is prepared to forego regular meals and a comfortable bed, but like nearly every other occupation it has its drawbacks, the chief of which is the difficulty and anxiety experienced in looking after the elephants, which have been taken. The most assiduous personal attention is necessary, if the mortality percentage is to be kept down, because none of the *phandis* and other men in the pilkhana have any particular interest of the fate of the captives, and an extra bunt or two from a large koonkie may inflict fatal injuries. Bringing in large quantities of fodder is wearisome work for all and likely to be scamped, which means that the new elephants get starved and weakened. It is said that the most prominent object in the old Government pilkhanas was the Triangle, and no large establishment of elephant men could be run properly, if punishment suitable to the class of men could not be inflicted.

The most ineradicable fault that the men have is their fondness for spearing the wild elephants on all possible occasions. If an elephant will not put its foot into the prepared noose, the

foot is speared; if the animal does anything wrong with its trunk it is speared and so on, until the poor beast is a mass of punctures and galls from the ropes. Last year I tried quite different tactics with a young female, which we took over to train, and as I was the medicine man myself, anyone who gave me more work to do by adding to the number of wounds was promptly "adjusted" in the most suitable manner. The result has been a most triumphant success. The animal has been perfectly trained, is absolutely obedient and goes this season into the stockades as bold as brass. Two young tuskers, bigger than she, who were caught at the same time, are still very kutcha in their training, and are scared to death in the stockades, where they ought to show more pluck than a small female. Presently no doubt they will become good koonkies, but meanwhile all the pluck they showed, when first caught, has been hammered and speared out of them by bad treatment. A wild elephant is necessarily a handful to manage, especially as it has every intention to kill any human being who comes within reach, but there can be no doubt that it can be much more effectively trained, if not scared out of its wits by brutal treatment and it will very soon tolerate men if kindly handled. A good beating with a stick soon shows it that there is only one safe place to keep its trunk, while it will abandon kicking if the stick is similarly applied to its feet. A tusker, which we are now taking in hand, is proving most amenable to our rational method of treatment, and is settling down to his training sensibly and quietly.

Large elephants are naturally more dangerous to tackle than small ones, and require stern measures occasionally; but as it is impossible to make men sensible or humane by law, it will be a good day for the elephant, when only small ones may be caught, and at the same time closing the kheddahs will prevent the farther depletion of our decreasing stock. Complaints are frequently made of the havoc caused to crops by elephants, but the damage is almost entirely caused by solitary males, and measures for dealing with them are being considered. Those interested in elephant hunting are prone to try and make out

that hunting is the cure for this destruction of crops, but such a contention is easily refutable by examining the footprints in the paddy fields, and by asking the villagers. A case came to light last year where 18 out of 38 elephants, mostly breeding females, were killed in training by the mahaldar. The value of these beasts could not have been less then Rs. 20,000, a serious ecomonic loss from every point of view, while every animal of the 18 was done to death, through ignorance and callousness, in the most hatefully cruel way. Too much of this cruelty and waste is associated with kheddahs, even when run by Indians of experience, to permit of the system being carried on, and its exposure will put an end to a great deal of suffering.

A. J. W. MILROY, I.F.S.,

Assam.

WALNUT EXPLOITATION IN HAZARA, N W. F. P

Early in August 1917, enquiries were made by the Forest Economist at Dehra Dun to find out if the walnut requirements of the Ishapore Rifle Factory for rifle butts, etc., could be supplied from Indian forests. As a result, in September 1917, a conference of all the parties concerned was held at Dehra Dun, and it was decided that the Hazara forests should endeavour to supply, annually, ten thousand sets of steam-seasoned walnut ½ wroughts, *i.e.*, an equivalent of about 3,300 c. ft of manufactured timber.

Immediately after this, fellings were started in Reserve Manshi B, in the Kagan valley, and a start was made with the erection of workshops and steaming plant at Jaba, 38 miles from Havelian, N.-W. R., by cart-road, of which some 6 miles is rough and 32 miles good cart-road. The site selected is in reserved forest land, thus avoiding land acquisition proceedings. By the end of December 1918, all the buildings and plant at Jaba had been erected and a first supply of steam seasoned walnut ½ wroughts had been made to the Rifle Factory at Ishapore. A brief account of the various operations involved in the manufacture and

steam-seasoning of these ½ wroughts may be of some interest to readers of the *Indian Forester.*

These operations fall under two heads :—

(*a*) In the Forest.

(*b*) At the Workshops.

(*a*) *In the Forest.*

In the Kagan Range of the Hazara Division, walnut is found growing gregariously in large patches as well as scattered in groups and single trees in Deodar, pine and fir forest on comparatively easy ground, at elevations varying from 6,500 –8,500 feet above sea-level. There is practically no natural regeneration as the walnuts are destroyed in large numbers by vermin, while many are collected by man for food. Generally speaking, the trees are branchy, the first branch appearing at not more than 25 feet from ground-level. Trees above 8 feet in girth at breast-height are mostly hollow at the base.

Fellings were based on the system of clear felling, all trees of 6 feet girth and above at breast-height being felled in the area selected for felling. 200 of such trees were felled in November 1917, at a cost of annas 7 per tree. It is important to carry out the fellings in autumn when the sap is down, with a view to reduce splitting in the wood before it reaches the workshops.

Logging is done with the saw and is, as far as possible, completed before the first snowfall, which renders further working in the forest impossible All large knots, especially where they occur on opposite sides of the boles at the same level, are entirely excluded and this necessitates cutting logs to lengths varying from 3½ feet to 9 feet in length. The cost incurred is annas 4 per log.

Sawing is done at a cost of about annas 4 per c. ft (including "godown" expenses) by sawyers mostly imported from Kashmir for the purpose. Only "slabs" were sawn 3 inches thick and between 4 and 12 inches in width The sapwood was in the first year excluded as far as possible, but this is not essential as the Rifle Factory also accepts sapwood. The average outturn comes to 35 c. ft. of "slabs" per tree.

Carriage.—This part of the work gave most trouble and was a long drawn out operation, the last planks not being delivered at the factory before 15th March 1919, *i.e.*, a period of 10 months since May 1918 when sawing was started. The carriage down to the main Kagan valley road, a distance of seven miles, was done by coolies, and then by mules, bullocks and donkeys along 29 miles of the road up to Jaba Workshops. The carriage was paid per maund, the cost being Re. 1-8 per maund or an average of about annas 14 per c. ft. This is the heaviest item of expenditure.

Precautions taken to prevent splitting before the timbers reached the factory were :

(*i*) The ends of planks were smeared with cow-dung.

(*ii*) The planks were kept in the forest and at all the immediate depôts in stacks and under cover.

(*b*) *At the Workshops.*

(*i*) Making of ½ Wroughts—

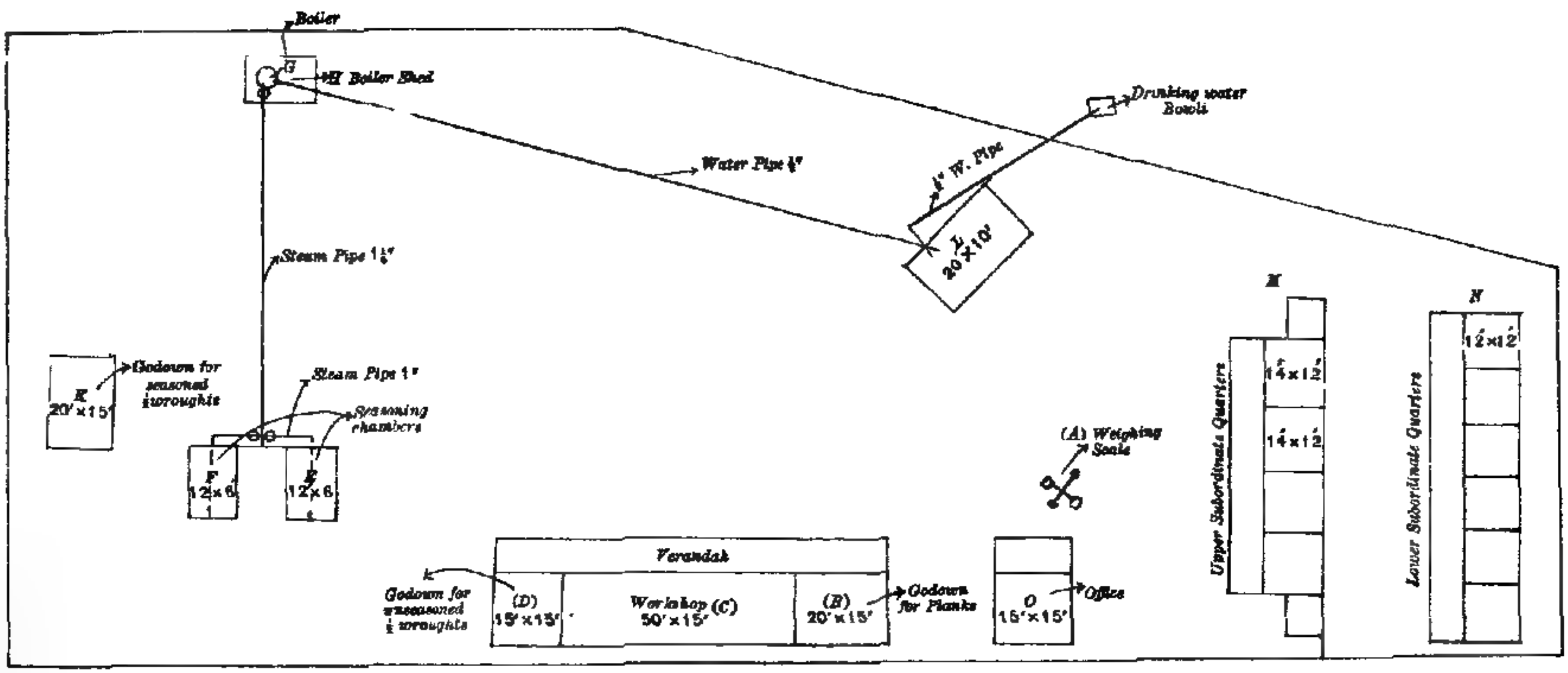
A site plan of the workshops is given in plate 21. On arrival at the factory and after being weighed on the scale, marked A on the plan, the planks are stored in godown B. Thence they are taken into Workshop C where the outlines of the ½ wroughts are marked on them by means of templates supplied by the Rifle Factory, Ishapore. Plate 22 gives the dimensioned drawing of these, there being four to a complete set, (*viz.*, Butt, Fore-end, Front and Rear Hand guards). The greatest care is required in tracing as the ½ wroughts have not only to be absolutely straight-grained but also free of all kinds of knots, shakes and inlocks and defeats of any kind. This selection of the best wood involves a good deal of wastage which amounts to as much as 60 per cent. of sawn planks. The long lines traced on the planks are then cut with frame-saws by sawyers, these sawn planks being afterwards made over to carpenters, who finally reduce the ½ wroughts to prescribed dimensions and who also plane all the four sides of each piece. At the end of the day's work these ½ wroughts are passed by the Head Carpenter and then transferred to the godown for unseasoned ½ wroughts, marked D in the plan, where they are kept until required for seasoning.

SITE PLAN

OF

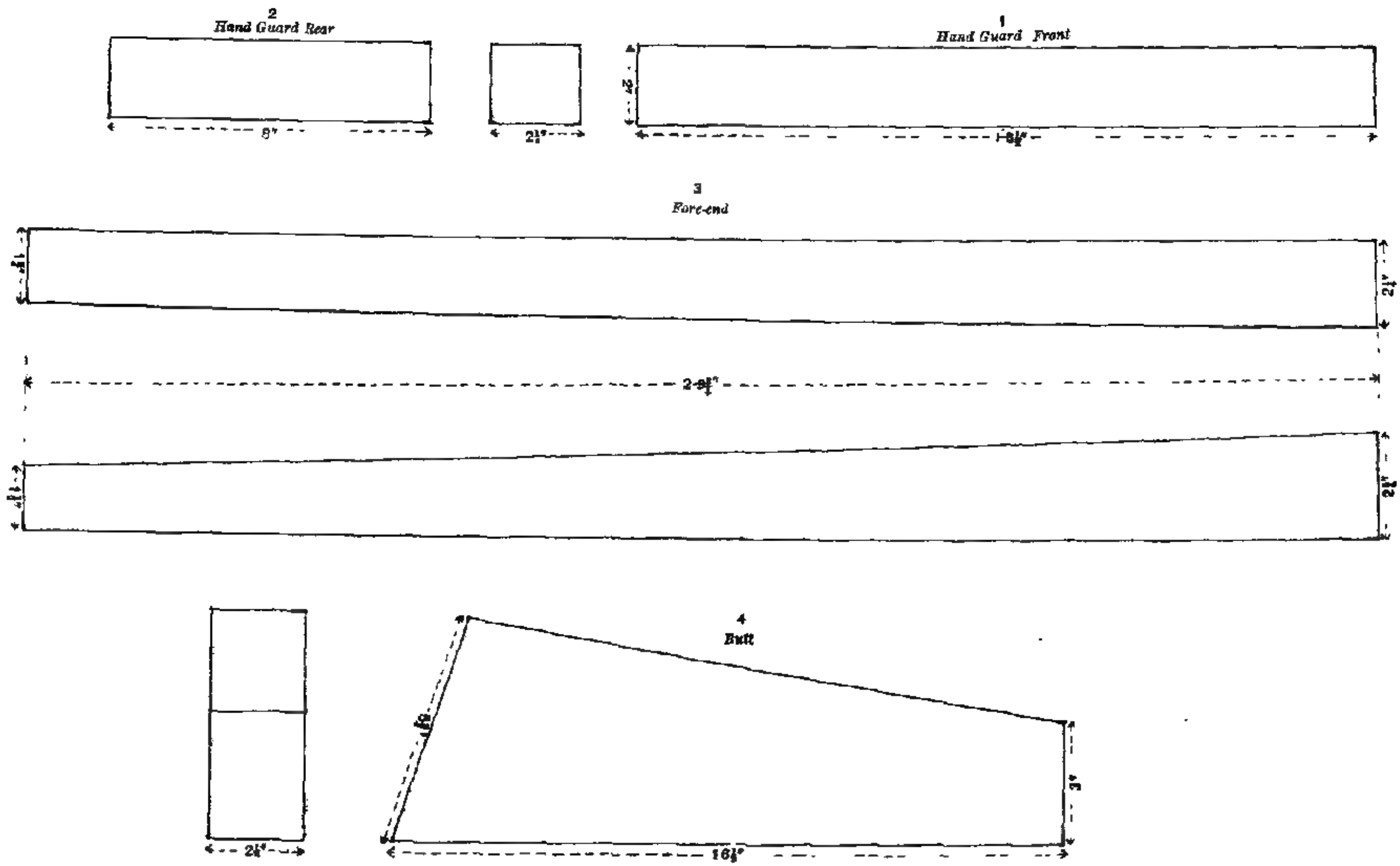
JABA WALNUT FACTORY.

Scale—1 Inch = 40 Feet.



HALF WROUGHTS

Scale—3 Inches = 1 Foot.



The cost of making the ½ wroughts comes to roughly annas 6 a set. As will be seen from the above, a good deal of manual labour is resorted to. To eliminate this, it may ultimately prove desirable to set up a band saw to be worked by an oil engine with a view to speeding up work and reducing working expenses but a decision on this point will be postponed until further experience has been attained.

(*ii*) Steam-seasoning—

The objects of steam-seasoning are threefold :—

Firstly.—It seasons the wood in a shorter time than in the case of natural seasoning.

2*ndly.*—It gives a uniformly pinkish dark brown colour to the wood which is originally of a greyish colour. The originally white sapwood also assumes this colour.

3*rdly.*—Dry rot, etc., is greatly reduced by the destruction of fungus spores and mycelium.

Process of seasoning.—The ½ wroughts to be seasoned are stacked in layers in two masonry seasoning chambers (marked E and F in the plan) built into the hill side, with 1 thick Deodar "lays" in between to admit of the steam being in contact with all sides of each ½ wrought. These stacks are wedged at the top against rails provided for the purpose to prevent warping during seasoning. Iron doors are then fitted against the opening in the front, and this renders the chambers absolutely air-tight save for two pipes at the bottom of the face of each chamber, which serve as outlets for condensed water. The steam is supplied to these chambers by means of pipes from a 3 N. H. P. vertical boiler (G in the plan) erected in the boiler shed (H in the plan). The pressure is never allowed to exceed 10 lbs. per square inch. The steam is supplied continuously day and night without a break for a period of from 3—4 weeks. It, however, appears that the period allowed is too long and experiments are now being started to find out if it is possible to shorten this period consistently with the attainment of the object aimed at. On the completion of the steaming period, the ½ wroughts are left in the chambers until

they cool down to within 10 degrees (Fahrenheit) of the temperature of the surrounding atmosphere.

The ½- wroughts are then removed to the godown (K in the plan) where they are again stacked with "lays" in between to dry, since the wood is saturated with water at the end of the steaming process. Experience has shown that as far as these seasoned ½ wroughts are concerned all sudden changes of temperature have to be studiously avoided, as otherwise they develop "shakes" which render them unsuitable for the purpose for which they are required.

After the ½ wroughts have got rid of all the absorbed water the ends of each piece are sealed with rosin diluted in kerosene oil, the sealed ½ wroughts are tied into bundles with ropes and are then ready for despatch to the Rifle Factory.

Water-supply.—For the purpose an excavated 5,000 gallons capacity masonry tank (L in the plan) has been built; the water is led into this from a spring tank, about a furlong higher up by means of a wooden water channel made of hollowed out Chil poles. From this tank the water is fed into the boiler by means of a ½" water-pipe. This tank is situated about 40 feet in vertical height above the water inlet of the boiler and consequently the water is fed into the boiler entirely by gravity.

In addition to the buildings alluded to above suitable quarters have been built, both for the upper and lower subordinates (M and N in the plan). A small office room (O in the plan) is also attached.

Cost.—The buildings, boiler, fittings, tools, etc., involved a total capital expenditure of Rs. 20,850. The cost per set including depreciation, interest on capital and a royalty of Rs. 2-8 per c.ft. of planks sawn in the forest comes to Rs. 5 *f.o.r.* nearest Railway station at present, but with more experience and improvements in methods it is quite possible that the cost will be materially reduced.

KHAN MUHAMMAD KHAN,
Extra-Assistant Conservator of Forests.

EXTRACTS.

LIST OF FOREST OFFICERS WHOSE NAMES HAVE BEEN BROUGHT TO THE NOTICE OF THE GOVERNMENT OF INDIA FOR VALUABLE SERVICES RENDERED IN INDIA IN CONNECTION WITH THE WAR UP TO THE 31ST DECEMBER 1918.

Issued with the Gazette of India, Extraordinary, July 29th, 1919.

Mr. H. R. Blandford, Deputy Conservator of Forests, Tharrawaddy Division, Burma.

Mr G. S. Butterworth, Deputy Conservator, Forest Department, Bombay.

Mr. F. F. R Channer, O.B.E., Deputy Conservator of Forests, Dehra Dun, U. P.

Mr. P. H. Clutterbuck, C.I.E., Chief Conservator of Forests, U. P.

Mr. W. E. Copleston, Conservator of Forests, Southern Circle, Bombay.

Mr. B O. Coventry, Conservator of Forests, Kashmir and Jammu.

Mr. L. C. Davis, Deputy Conservator of Forests, Burma.

Mr. A. J. Gibson, Deputy Conservator of Forests, Punjab.

Mr. H. M. Glover, Deputy Conservator of Forests, Punjab.

Mr. N. V. Holberton, Deputy Conservator of Forests, Burma.

Mr. R. W. Inder, Bombay Forest Department

Mrs. Lodge, wife of Mr. F. A. Lodge, C.I.E., Inspector-General of Forests, Hyderabad, Deccan.

Miss Lodge, daughter of Mr. F. A. Lodge, C.I.E., Inspector-General of Forests, Hyderabad, Deccan.

Mr. G. E. Marjoribanks, Divisional Forest Officer, Kanara Bombay.

Mr. R. G. Marriott, Deputy Conservator of Forests, U. P.

Mr. W. Mayes, Conservator of Forests, Western Circle, Punjab.

Mr. R. McIntosh, Conservator of Forests, Eastern Circle, Punjab.

Mr. A. W. Moodie, O.B.E., Deputy Conservator of Forests, Katha Division, Mandalay, Burma

Chaudhuri Muhammad Aziz, Forest Ranger, Punjab.

Nazir Abbas, Extra Assistant Conservator of Forests, Nimar, C. P.

Mr. H. L. Newman, Deputy Conservator of Forests. Bombay.

Mr. J. N. Oliphant, M.B.E., Deputy Conservator of Forests, U. P.

Mr. R. Parnell, Deputy Conservator of Forests, Hazara Division, N.-W. F. P.

Mr. R S. Pearson, F.L.S., Forest Economist, Imperial Forest Research Institute, Dehra Dun

Mr. A. Rodger, O B.E., Deputy Conservator of Forests, Rangoon.

Pandit Sunder Lal Pathak, Conservator of Forests, Gwalior State, Central India.

Rai Bahadur Shyam Sunder Lal, Conservator of Forests, Indore State, Central India.

Mr. H. Tireman, Deputy Conservator of Forests, Coorg.

Mr R. S. Troup, Indian Munitions Board, Government of India.

Mrs Waller-Senior, M.B E., wife of Mr. Waller-Senior, late Forest Department, Mysore.

Miss Waller-Senior, daughter of Mr. Waller-Senior, late Forest Department, Mysore.

Mr. H. L. P. Walsh, Deputy Conervator of Forests, Mu Division, Burma.

Mr. H. W. A. Watson, Deputy Conservator of Forests, Zigôn Division, Burma.

Mr. R. M. Williamson, Indian Munitions Board, Government of India.

Mr. H. L. Wright, Deputy Conservator of Forests, Kangra Division.

J. H. Lace, C.I.E., F.L.S.—A frequent visitor to the New Herbarium, and one held in very high regard by members of the staff there, passed away in June last at his home at Exmouth, Devonshire. John Henry Lace was trained for the Indian Forest Department at the National Forest School at Nancy, France, and passed out in 1881. On arrival in India he was appointed to the Punjab, and soon made a name for himself as a keen forest officer and accurate botanist. During his service of over thirty years he served not only in the Punjab, but in British Baluchistan, Bengal and Burma. While in Baluchistan he made an extensive collection of plants which resulted in the publication of "A Sketch of the Vegetation of British Baluchistan" by himself and Mr. Hemsley in Journ. Linn. Soc., xxviii (1891), p. 288. At one time he was Assistant Inspector General of Forests, at another he was for a short while Principal of the Forest College at Dehra Dun, and again he once officiated as Inspector-General of Forests. His last appointment was that of Chief Conservator of Forests in Burma, which he held for about five years, doing excellent work not only in forest management but in the study of the flora of some of the less-known regions such as the Shan States and the hills around Maymyo. His useful and accurate "List of Trees, Shrubs and Climbers of Burma" is the present standard work on the subject and the beautifully prepared specimens collected by him are of the greatest value to Indian botanists. He presented a nearly complete set of his collections to the Kew Herbarium, and we are glad to hear that his own set has now become the property of the Herbarium of the Royal Botanic Garden at Edinburgh. Many new species found by him in the Burma forests have been described in the Kew "Decades" from time to time, chiefly by himself. His death at the age of over sixty years was rather sudden, and came as a shock to his many friends at home.

[G. S. G. in *Kew Bulletin*.]

GRASSES IN ASSAM SUITABLE FOR THE MANUFACTURE OF PAPER PULP

A good deal of attention has been paid during recent years to the question of the utilization of bamboos for the manufacture of paper pulp, and two publications have already been issued by the Forest Research Institute on the subject. From time to time enquiries have also been made by interested parties as to the possibility of utilizing the elephant grasses for the same purpose, and a publication dealing with the chemical side of the question has been published by Mr. Raitt, entitled "Report on the Investigation of Savannah Grasses as Material for Production of Paper Pulp" [*The Indian Forest Records*, *Vol. V*, *Part III*] Such enquiries cannot be considered complete without a consideration of the closely associated questions of total available outturn, yield peracre, cost of extraction to a possible factory site, local conditions, lines of communication, labour, etc., concerning which up to date nothing has been published. This subject has, however, not been entirely overlooked, and in 1916 and again in 1917, a careful inspection was made of the grass areas on the Monas river in Assam, with a view of collecting data on the above points.

An extensive grass area was found to exist in the angle made by the Brahmaputra and Monas rivers, on the east bank of the former opposite Goalpara, comprising the villages of Loti bari, Amguri, Pildardhara and Nayashastra, in the Barpeta sub-division of the Kamrup Division. The grass in this area is estimated to cover some 15,800 acres, while a similar area exists on the south bank of the Brahmaputra below Goalpara.

The most important species of grass found in these areas are Khagra (*Saccharum spontaneum*) and Batta (*Saccharum narenga*) with patches of Nal (*Phragmites karka*) on the more swampy ground. Sample plots were taken to determine the outturn per acre, in order to obtain an approximate estimate of the annual yield. The grass was cut over a given area and weighed green and again when dry, from which it was ascertained that Khagra yielded 7·5, Batta 3·5 and Nal 8·04 tons per acre of dry grass. It would not be possible to crop the same areas annually, and Mr. Hole, the Forest Botanist, who has for years studied these grasses

to determine their mode of growth, states that Khagra and Nal can be cropped every other year and Batta every third year. By adopting this rotation we get in round figures a sustained annual yield of 4 tons for Khagra and Nal and 1 ton for Batta. Khagra is found over a greater extent of the area than the other two species, so that were an average to be struck, based on actual areas covered by these three species, this average would probably work out to over 3 tons per acre; for safety's sake it is assumed that all three species occur in equal quantities, and under such an assumption we may expect to get a sustained yield of 3 tons per acre per annum or a gross annual yield of 47,400 tons per acre of dry grass, which, put at a low yield of 33 per cent. of pulp, gives over 10,000 tons of pulp per annum.

The cost of extracting a ton of air dried grass to a possible factory site at Jogigopa, a small tahsil town in the Bijni Estate, just below the junction of the Monas and Brahmaputra rivers, worked out as follows:—

Khagra (*Saccharum spontaneum*), per ton Rs. 7-8-0.

Batta (*Saccharum narenga*), per ton Rs 6-2-0.

Nal (*Phragmites karka*), per ton Rs. 8-8-0.

Hand samples of the above grasses were sent to England to be tested on a laboratory scale, while several tons were sent to an Indian paper mill to be made into paper The results were satisfactory and proved that a very fair quality of paper can be produced from these grasses at a relatively low price. Small samples of such paper can be obtained by persons interested in these grasses from the Forest Economist, Forest Research Institute, Dehra Dun, who can also supply further details regarding the above described area.

It may be remarked that the Monas area was dealt with first by reason of its relative proximity to markets and sources of labour, and it may be superfluous to add that there are other very extensive and doubtless suitable areas in the Brahmaputra Valley and throughout Burma which have not yet been examined.

Dr. W. H. Brown, Ph.D., of the Bureau of Forestry, Philippines, has recently published a pamphlet on "Philippine Forest Products as sources of Paper Pulp," in which he deals with Khagra

(Saccharum spontaneum) grass. He states that Mr. Richmond found that the pulp bleached to a good white colour with only 2·3 per cent. loss in weight, by the use of 5·7 per cent. of bleaching powder, calculated on the original weight of the material digested. These results confirm those obtained in India.—[*Indian Trade Journal.*]

UTILIZATION OF PAPER YARNS.

Paper yarns are now being used for an extremely wide range of purposes. One of the principal uses is for the manufacture of cordage, ranging from fine twine up to coarse rope. Paper string is mostly made from paper yarn alone, but in some cases the paper is spun on a central core of fine hemp twine, and in other cases on a fine metal wire. Another important use is for the manufacture of sacks and bags to replace those made from jute and hemp. During the war enormous quantities of paper yarn have been used for making sand-bags for army purposes and for storing produce, these bags having the advantage that they are free from odour. Paper yarns are also employed for the manufacture of braiding, webbing, tent canvas, waterproof canvas, tarpaulins, mats, upholstery, carpeting materials, wall coverings, as a foundation for linoleums and oil cloths, and for woven boards which are said to form a suitable substitute for 3 ply wood Another use for the yarn is for the manufacture of a leatner substitute, especially for machine belting. For the latter purpose the yarns are spun from parchment paper, and are afterwards wound on spools, and woven into fabrics which are stitched together to make belting of the required thickness. Paper yarns, which have been specially impregnated, are stated to be used in the cable industry, chiefly as a partial or complete substitute for jute, as a packing between the lead sheath and the iron armour of the cables. In the coating of lead-sheathed cables with waterproof composition the winding of paper yarn is as efficient as the old jute winding, since it adheres better to the lead sheath, and blends with the composition to form a perfectly flexible and waterproof covering.—[*Indian Engineering.*]

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SOME NOTES ON THE USES OF TIMBER IN AEROPLANES.

It will perhaps be best to consider how and why an aeroplane flies, before passing to a consideration of its parts, and how wood can be used in them.

If an object is passed rapidly through the air, it displaces a certain volume of air, and causes a vacuum in its wake. The surrounding air tends to fill up this vacuum, and the object itself is attracted towards it. If the object is a flat surface then a vacuum will be formed over the rear part of it: the "trailing" part. In aeroplane construction this fact is exploited for the purpose of making the machine rise. The "leading" edge of the wing disturbs the air, and causes a vacuum over the trailing portion. The wing is so fitted to the machine, that the vacuum is all on the top surface, and therefore the wing tends to be attracted into the vacuum and to rise in consequence. The forward motion of the machine is developed from the propeller, and the tail plane gives a fore and aft balance, whilst the elevator attached to it causes the machine to rise or fall at the pilot's will. Thus the

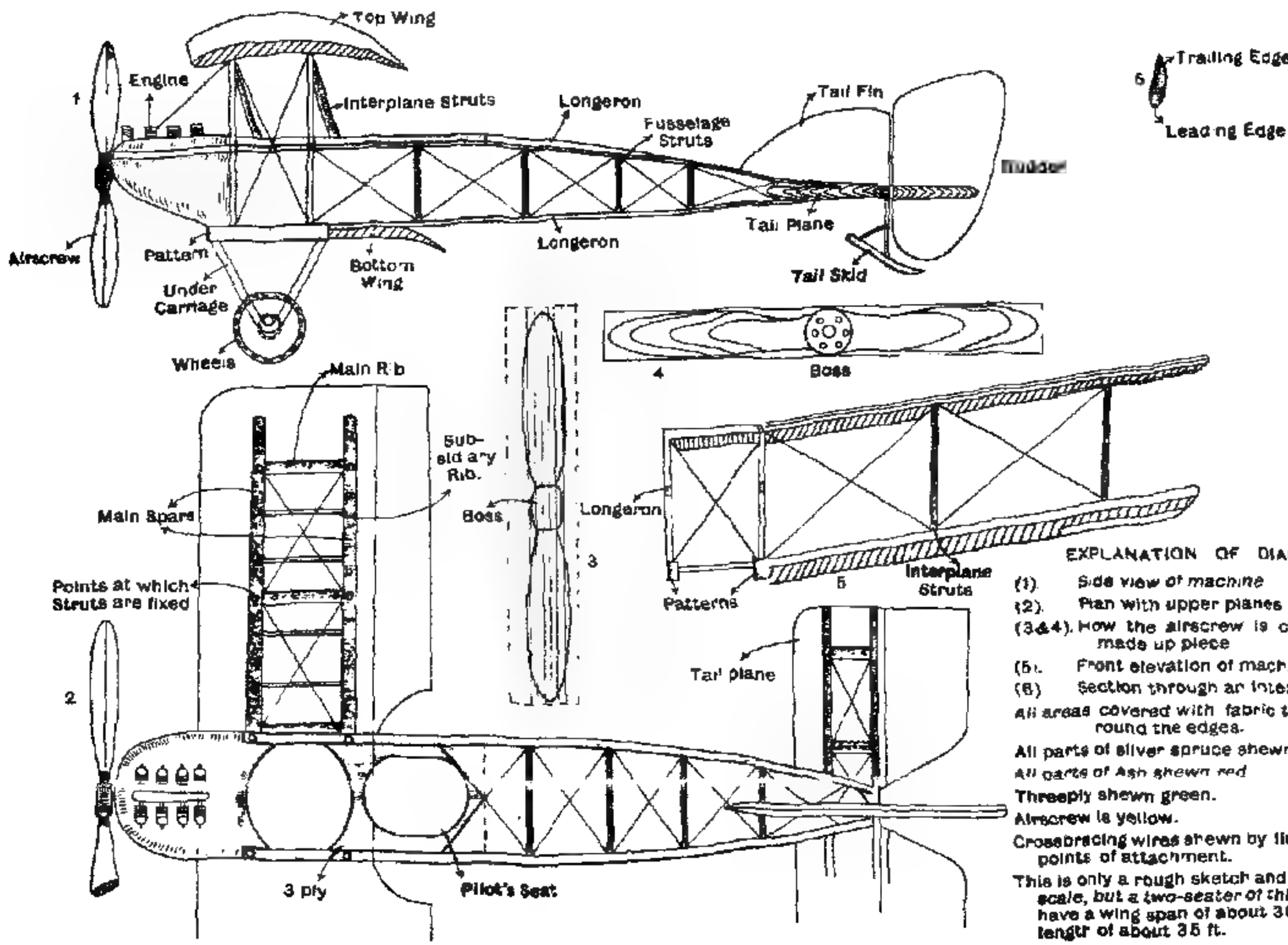
machine flies because the propeller draws it through the air, which is disturbed and forms a vacuum over the top of the planes, which is used to lift the whole structure, but at the same time the under-surface beats against the air thus developing an additional thrust in the upward direction. The upward lift due to the suction exerted by the vacuum above the wings is at least twice as strong as the upward thrust from below the wing. Turning motion in the horizontal plane is achieved by the rudder just as in a boat.

In rising from the ground, the machine runs on its wheels till it has enough speed for the forces acting on the wings to lift it off the ground. The tail can usually be lifted first, and the tail-skid, which acts as a brake, is raised from the ground. In landing the reverse process takes place, and the pilot lets his machine lose speed within a few inches of the ground till the wheels touch and tail can be depressed without causing the machine to rise, thus bringing the tail-skid hard on to the ground and using it as a brake.

In the annexed diagram (Plate 23) the parts of a B. E. type tractor biplane are roughly sketched.

Some parts of a machine are made of wood and some of metal. Everything is as light as possible, as very little weight makes a great difference in the buoyancy of a machine. The machine is built throughout on the principle of the box girder, *i.e.*, the outer sides of a four-sided figure are made of a rigid compression-withstanding material, whilst there are diagonals from each corner, crossing in the middle, of material which well withstands tension strains.

The spars and longerons in a machine are connected at intervals by struts (the outer sides of the above four-sided figure) and are cross-braced with wires or cables (the interior diagonals of the above). With one or two exceptions, the struts in a machine are all made of wood. The spars and longerons are always of wood. For these purposes, wood having the requisite strength is found to be lighter than metal. In addition, wood can be easily shaped and formed into the necessary stream-line contours. Further, wood



EXPLANATION OF DIAGRAM

(1). Side view of machine

(2). Plan with upper planes removed

(3&4). How the airscrew is cut from the made up piece

(5). Front elevation of machine

(6) Section through an interplane strut.

All areas covered with fabric tinted brown round the edges.

All parts of silver spruce shewn blue

All parts of Ash shewn red

Threeply shewn green.

Airscrew is yellow.

Crossbracing wires shewn by lines between points of attachment.

This is only a rough sketch and in no way to scale, but a two-seater of this kind would have a wing span of about 30/35 ft., and length of about 35 ft.

does not crystallize and weaken under vibration as metal is liable to do.

All parts of the machine, which come into contact with the air, will offer "head-resistance," if the air beats against them as the machine proceeds in its course. If this "head-resistance" and the corresponding vacuum caused are to be done away with, all such parts must cleave the air as much as possible, and leave as little vacual space behind them as possible. This object is attained by "stream-lining", *i.e.*, the part is cut to cleave in its forward passage, and to have a tail which fills its vacual cavity behind, thus preventing back suction. The air then passes by, gently lapping the part without being able to grip it. The section of an interplane strut is given.

The wings are hollow, and have a linen covering above and below, which is stretched on a wooden frame-work. This is internally braced by wires, which can be brought up to the necessary tension by an arrangement of antagonising screws. Thus the structure is on the box-girder principle as described above. The main part of the wing is in the spars, by which the wing is attached to the body of the machine. One of these is near the leading edge of the wing and one near the trailing edge. Between them are the main ribs and the subsidiary ribs The main ribs and spars take up all the weight of the machine and all the strains of the wing whilst flying. The interplane struts are situated at the junction of a main spar and main rib. Such attachments are made by steel bolts running through the wood. The bolt heads rest on steel plates, which prevent them from sinking into the wood, and these plates are made the points of attachment for the cross-bracing wires. All the above main spars, struts and ribs are usually made of silver spruce (*Abies sitchensis*), and the interplane struts are cut to stream-line shape as described above, whilst the spars and ribs are given a girder-like section by sinking grooves on either side. These grooves are interrupted at intervals and the original thickness of the wood is left. This is done so as to retain the strength of the timber, whilst achieving the greatest possible lightness.

Between the main ribs there are a few subsidiary ribs connecting the spars. The object of these is to keep the fabric of the wings taut. They take up very little of the strains in the wing. For this reason they are very light and are made in a girder shape. The upper and lower edges are made of a single thin piece (1/8") of alder or ash. The web connecting these parts is of three-ply. This three-ply is of ash or birch outer laminæ with a tongue of alder very often, but many kinds of wood are used for this purpose. The web is further lightened by cutting out circles of the wood, so that the rib seen from the side has a series of large holes running through it.

From the above it will be seen that all parts must be free of flaws to the greatest possible extent. Any flaw will form a centre of weakness, which will sap the efficiency of the whole member in which it is present.

In wood such flaws are usually knots, or lack of straightness in the fibre of the timbers. The safety of an aeroplane is denoted by a factor, which denotes the amount of strain greater than that which the weakest member of the machine can bear. Thus a safety factor of 10 would mean that the weakest part of the machine used in supporting it in the air would withstand 10 times that strain which would break it. As all machines are designed to have a factor of about 10, it will be seen that a bad knot in an otherwise excellent piece of timber may reduce its value to very little, as such a knot would break easily, and would tend to loosen and split if it came into vibration.

Timber used in construction must be light in the first place. For spars it must be very straight-grained and free from knots, as although very small knots are allowed, they might interfere with the drilling of the bolt holes. It must be possible to cut clean holes for the bolts, and the wood must therefore be entirely free from any inclination to split or splinter, when the borings are made. These borings are usually lined with a copper tube which is of thin metal and exactly fits the boring, whilst its own internal diameter just admits the bolt. This prevents the wood from being damaged when the bolts are taken out for dismantling the machine, etc.

For the interplane struts which are exposed to the air throughout their length the timber must be easily moulded so as to be shaped to the necessary stream-line section. They must also be highly polished. The polish is necessary, because when the air rushes over the machine there is friction between the air and the surface of the machine. To reduce this to the minimum all parts are smoothed and polished as highly as possible. This friction is called skin friction In the same way the wing fabric has dope and varnish applied to it. The Airscrew (Propeller) is likewise smoothed and polished.

All parts of a machine made of wood are not so made to withstand compression strains only. Various parts are peculiarly liable to vibration and shearing strains. In some of the older machines the under-carriage was made of ash, because it would well withstand the vibratory strains it underwent when the machine was landing. In nearly all machines the longerons and patterns were made of ash. The longerons are the long narrow pieces which compose the fuselage and connect the wings and tail. They are held together through their length by struts and cross-bracing wires. The struts are ash or silver spruce. The patterns are found, where the longerons pass under the body of the machine. To them the under-carriage and lower planes are fitted. The engine is carried on steel tubes in line with the top longerons; they are further supported below by a frame-work of ash struts cross-braced with wires.

When the machine is in flight, the tail is liable to be whipped slightly in almost any direction, as the machine turns, rises, falls, etc. A wood with great elasticity is required for its construction. Ash has been found most suitable for the purpose.

In every machine there are places where great pliability and strength are required for the materials used, and these must also be light. This is necessary for the purpose of shaping them to the necessary stream-line form, *e.g.*, the fuselage in front of the pilot's seat in the old B. E. type machine. For this work 3-ply wood has been found most excellent, as it can be bent in graceful curves, is light and sufficiently strong. In some machines a large

part of the fuselage towards the tail has been made of this in place of fabric. In such cases the strength of the 3-ply was sufficient to render unnecessary many of the cross-bracing wires between the longerons, as the 3-ply firmly fixed to the longerons was able to do their work.

Ash can readily be bent to various shapes under steam, and has been used for bent parts. Such bent parts do not always take quite the necessary shape to satisfy the stream-line requirements, and then mouldings are finished off by means of farings composed of such light woods as poplar, willow, etc. Such parts have only to complete stream-line contours, not to take up any of the real weight of the machine.

One very important part of the machine has not yet been touched on. This is the Airscrew or Propeller. This member is always made of wood. Its construction is of great intricacy. The strains running through it are very complex. A shearing strain runs through the arms of the propeller tending to make each part of the blade creep over that next it. To find a wood that will stand up to this a very close-grained one is required. If it were of an open grain, the various layers of the wood would tend to creep and the wood might be expected to crack along such places as the junction of two annual rings. It must also be light and capable of taking a high polish. In order that the engine might run smoothly it has to be of an even density throughout, as any variation, however slight, in the relative weight of the blades at once affects an engine revolving at the high speeds, which are developed in aeroplane motors. It was found impracticable to cut even a two-way propeller out of a single piece of timber. Accordingly layers of wood or laminæ were cut, and very firmly glued together; the final propeller being machined out of the block so formed. The laminæ are about $\frac{3}{4}''$ thick, and the number in a propeller vary according to the thickness of the thickest part. In making the propeller the laminæ of wood are laid horizontally one above the other, but so that each is at right angles to the main axis of the machine when the propeller is finished. In the inished propeller these laminæ tend to creep

over each other, and to counteract this in some cases the laminæ have been given a serrated surface. The serrations interlock when the laminæ are laid together. These serrations are quite fine (1/8" in depth) and run along the grain of the wood.

In a 2-bladed airscrew all the laminæ are formed of single strips of wood, which are continuous throughout their length. In a 4-armed airscrew every other lamina in each blade stops at the boss, so as to allow a lamina of the other blades to be continuous from end to end. Thus only half the laminæ in each blade are continuous. At the boss all the laminæ are firmly fixed together, a single lamina of one blade passing between two laminæ of the other blades.

One of the most important attributes of the finished airscrew is its pitch. The pitch is the angle at which the working face of the propeller blade meets the air. The blade is so moulded that all parts exert an equal pull, and are under the same strain. In order that this may be so, the arm of the blade is thickest at the base and tapers down to the tip. Hence the centrifugal force developed by mere whorling tends to be the same all along the blade, as the part farthest away from the boss is the lightest. Now as the blade passes through the air it works as though it were a bolt being screwed into a nut, and the strength of its grip will vary with the pitch of its blade. In order that this may be similar all along the blade is so cut as to displace the greatest amount of air near the boss, and the pitch becomes altered up to the extreme tip, where practically no work is done at all. The tip is flat and offers the least resistance to the air, being little more than a kind of cutting edge, whilst the base of the blade offers far greater resistance, and a much flatter surface to the air as it revolves.

The edges of the blade are called the leading and trailing edges; the leading edge being that which faces in the direction in which the blade turns, and which first cuts the air. Behind this edge the blade is stream-lined off as much as possible. The whole blade is highly smoothed, polished, and varnished, so that it may not develop friction, but merely thread its way forward.

The propeller is bolted to the engine shaft by a series of bolts, which pass through the boss, and at the same time compress the boss between two plates, back and front, whose object is to disperse the pressure of the bolt-heads, and prevent them eating into the wood. It gives them a good seating and prevents the wood from being damaged.

From the above it will be seen that timber for propellers must be able to withstand torsion and shearing strains; be light; take a good polish; have resilience, be closely grained; readily worked; capable of binding firmly when glued; have a very uniform density; not liable to split.

The wood usually used for propellers is "Mahogany." This name Mahogany is a trade term and probably covers more than one kind of timber. In some German machines walnut has been tried. Ash has been used in alternate laminæ with Mahogany to give the blade greater spring. The propeller must have considerable spring in it, as the propeller when working full out tends to be bent forwards from the tips of the blades towards the centre.

Experiments have been tried in the direction of electro-plating the blades with copper. It was thought that this would take a high polish and would help to bind the laminæ of wood together, at the same time giving a protection to the wood against hail-stones and small pieces of soil, etc., which are kicked up as the machine starts and often dent the wood.

From the above notes it will be seen how great a part wood plays in the construction of aeroplanes. The species dealt with have been :—

Ash (*Fraxinus excelsior*) ...	for resilience, moulding under steam, compression.
Silver Spruce (*Abies sitchensis*)	for compression, moulding.
Mahogany	for torsion, shearing, moulding, polishing, resilience.
Willow	for light mouldings.
Poplar	Do.

Birch (*Betula alba*)	...	for 3 ply
Alder (*Alnus glutinosa*)	...	Do.
Walnut (*Juglans nigra*)	...	for torsion, shearing, moulding, polishing, resilience.

All the above are further chosen for their lightness. If woods having their strength and powers combined with greater lightness can be found, they would displace them. Can India do this?

All the above timbers have to be highly seasoned, and those which crack in seasoning or weaken or warp are useless.

Besides the above timbers used there are other forest products required :—

Rubber.
Materials for making varnish
Fibres for fabric,

Rubber is used for wheel tyres and "shock absorbers." The wheels are carried on a light axle, which again is attached to the machine by rubber bands specially prepared in fine threads contained in a woven sheath; the finished article being about $\frac{1}{4}-\frac{1}{2}'$ in diameter for two-seater machines. These bands are wound over the axle and the under carriage in the appointed places. They are applied in a particular way and yards are used for one machine. When finished the shock absorbers allow the wheels to bump on the unevenness of the ground without their full force being transmitted to the main body of the machine.

Varnish is used on all exposed parts of the machine. Dope is a fluid specially used for application to the fabric to make it taut after it has been attached in position. Varnish and dope also give a waterproofing effect. Varnish is often applied over the dope to reduce skin friction.

Fabric is the material with which the wings are covered and other parts of the machine It is made of the best Irish linen.

A. N. DAVID, I.F.S.

16th April 1919.

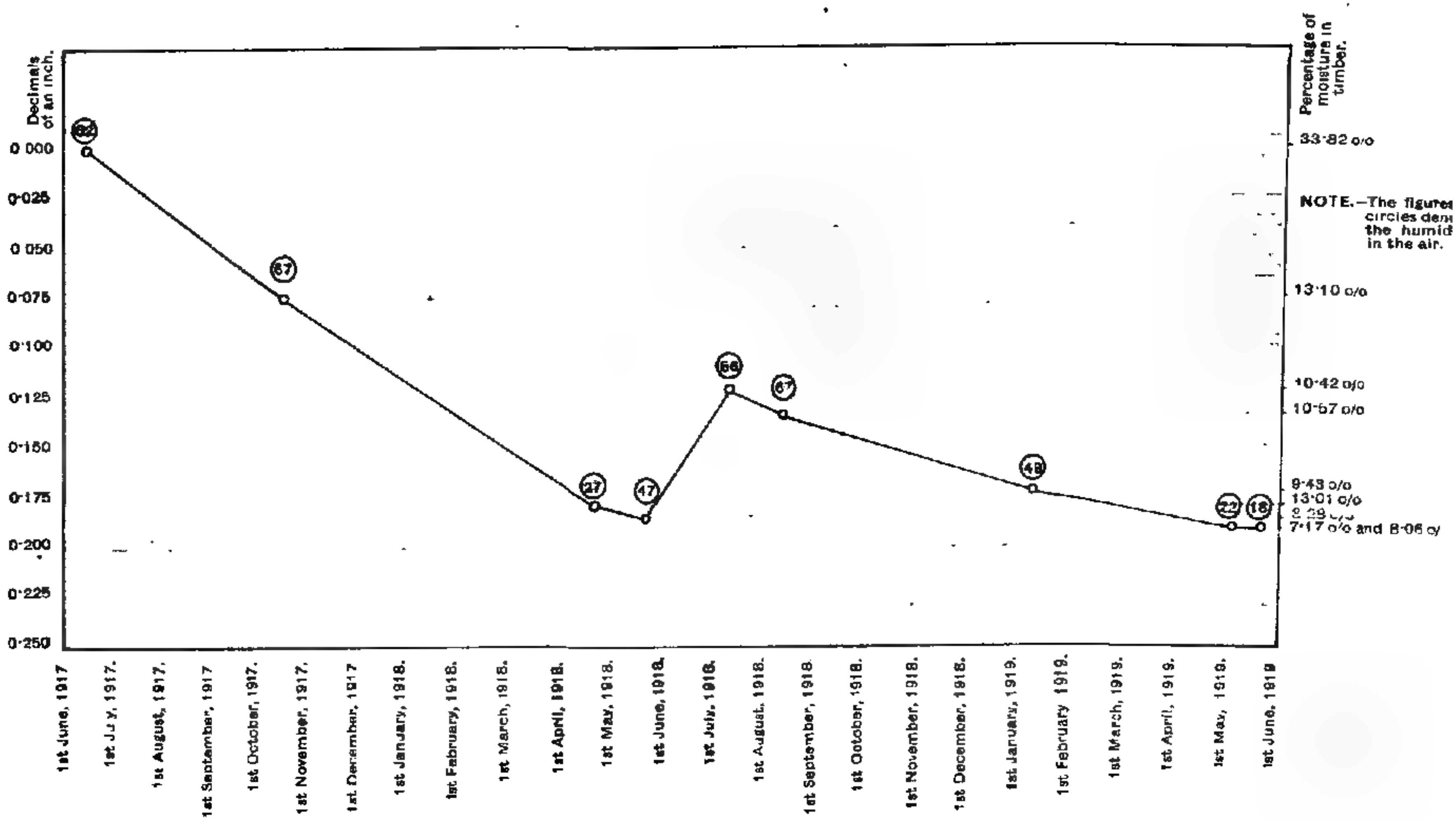
EXPERIMENT CARRIED OUT TO DETERMINE THE CONTRACTION ACROSS THE GRAIN WHICH TAKES PLACE IN TEAK *(TECTONA GRANDIS)* WHILE SEASONING.

The object of this experiment was to determine the amount of contraction which takes place in teak timber, when passing from a green to an air-dried state, and also to ascertain what effect an increase or decrease of humidity in the air had upon the timber after reaching an air-dried condition. Similar experiments have been carried out on the same lines with *Cedrela Toona* and *Pinus longifolia* timbers, with a view of ascertaining what allowances have to be made when converting those timbers when in a green state, in order that they may contract down to standard dimensions. The results of these experiments have been published in Forest Bulletins No 15 of 1913 and No. 37 of 1917, respectively.

The machine in which the contraction experiments were carried out was that described in the former Bulletin. An average sample of Allapilli Teak from the South Chanda Division of the C. P. was selected for the experiment, cut on the quarter, to size 12" × 12 × 1, and readings taken for expansion and contraction across the grain. The tree from which the plank was prepared was felled on the 31st May 1917, converted on the 2nd June 1917, and put into the machine on the 13th June 1917, at which time it contained 33·82 per cent. of moisture. Readings were taken at intervals during the next two years in the hot weather, and first two months of the monsoon at intervals of about a month and at longer intervals during the dry season. The machine is fitted with two dials and pointers marked A and B, the arms connected to which are placed roughly one-fourth of the distance from each

SPECIES.—TECTONA GRANDIS.

Curve demonstrating contraction of plank while seasoning, percentage of moisture in the timber, and percentage of humidity in the atmosphere on corresponding dates.



end of the plank. The reading on the dials, the percentage of moisture in the timber and the humidity in the air on the several dates of observation are recorded below :—

Size of plank	Date on which readings were taken.	Reading of contraction on dial, in decimal of an inch.			Percentage of moisture on date of observation.	Humidity in the air at 2 p.m.
		A	B.	Average of A and B.		
12″ across the grain and one inch thick	13th June 1917	..	..		33·82%	62
	13th Oct. 1917	0·065	0·085	0·075	13·10%	67
	20th Apr. 1918	0·175	0·185	0·180	13·01%	27
	20th May 1918	0·175	0·200	0·187	8·28%	47
	9th July 1918	0·110	0·135	0·123	10·42%	86
	11th Aug. 1918	0·130	0·140	0·135	10·67%	67
	9th Jany. 1919	0·155	0·170	0·162	9·43%	49
	2nd May 1919	0·180	0·205	0·192	7·17%	22
	20th May 1919	0·180	0·205	0·192	8·06%	18

To illustrate more clearly the state of the plank while passing from an absolutely green to air-dried condition, a curve has been prepared, which is appended to this note (Plate 24).

The maximum contraction across the grain amounts to 0·192″ or when cutting green teak an allowance of roughly 1/5″ should be made for every 12″ of breadth of planking. The allowance found necessary of *Pinus longifolia* was 1/4″, while that for *Cedrela Toona* amounted to as much as 1/2.″

On the 20th May 1918, the plank had contracted 0·187″, while on the 20th May 1919, it stood at 0·192″, or only 0·005″ difference. On the other hand during these 12 months, in the monsoon from the 20th May 1918 to the 9th of July 1918 it had expanded 0·070″, due to absorption of moisture, the humidity in the air having risen from 27 to 86. Now this experiment is of special interest in that it demonstrates the relation of expansion to air humidity and the percentage of moisture in the timber.

During the first 12 months, in spite of the plank after being laid down to season at the beginning of the monsoon, it steadily lost moisture, which resulted in uniform contraction, until in May 1918, when it had reached a thoroughly air-dried state and had contracted to nearly its maximum limit. As the humidity in the air rose with the advent of 1918 monsoon, the timber re-absorbed a small amount of moisture, *e.g.*, 2 per cent., the air humidity rose from 27 to 86 and the plank expanded 0·07 of an inch; then as the cold weather set in and the atmosphere became dry, the moisture again evaporated out of the timber, which resulted in steady contraction until in the hot weather of 1919 the timber had dried out to 7·17 per cent. of moisture. These experiments show that even teak, after it has reached a thoroughly air-dried state, as was the case in May 1918, is not at once fit for use for high class work. As time goes on teak becomes less and less liable to be affected by climatic conditions, until it finally settles down and maintains a constant shape. How long it takes to do so is generally put at about eight years, during which period the tree has stood girdled for three years, the timber remained in the log for at least one year and during the remaining time has been stored under cover as converted material.

R. S. PEARSON, I.F.S.,
Forest Economist

The 3rd June 1919.

STANDARD SYMBOLS AND COLOURS FOR FOREST MAPS.

1. At the recent Board of Forestry in Dehra Dun a proposal was received from Colonel Sir G. P. Lenox-Conyngham, Kt.; R.E., F.R.S., for the standardizing of symbols and colours for forest maps. A copy of this is printed. The proposals did not apparently include working-plan maps. Presumably everyone will agree that this is desirable, but there will doubtless be differences of opinion as to how far it is possible to go.

I do not know what resolution the Board passed on the subject, and many of these remarks may be superfluous.

The object of this article is to start a discussion in the hope that the subject will be taken up by the next Sylvicultural Conference. Being intimately connected with working-plans, it presumably comes within their province.

2. Three principal maps are used in forest work :—The *plain standard print* taken direct from the plate.—This should show permanent items only and naturally needs symbols for everything shown. It thus gives the symbols for the items in Colonel Sir G. P. Lenox-Conyngham's Groups A, B and D without the colours, but not those in Group C. Temporary features should not be shown as, if shown, it would necessitate the preparation of a new set of plates each time such temporary features were changed, for, although a few small alterations can be made on a plate, it is not possible to make many changes.

For example, if coupe boundaries are marked on the original plate with symbols it is not possible to delete them and replace them by a new set at the revision of a working-plan. It would mean redrawing all the plates—an expensive and laborious process.

This *plain standard print* is only used by the forest staff for actual mapping work, *e.g.*, the exclusion of a new forest village, the alignment of a new road, etc.

3. *The coloured standard print.*—This is exactly the same map as under para. 2 but shows all boundaries, temporary and permanent in their colours and is the map generally used in the forest.

The alteration of the temporary boundaries at any time does not cause any alteration of the original plates, it only necessitates sur-printing the colours along the new boundaries on a set of plain standard prints.

The above two maps are on the scale of 4" = 1 mile.

4. Some alterations should be made in Colonel Sir G. P. Lenox Conyngham's list. Under Group B, items 4 and 8, there is a symbol for sub compartments, that is this symbol is printed in the plain standard print and is marked on the original plate. Also the colour given on the coloured standard print is green which is the colour for *permanent* boundaries.

A sub-compartment is the most temporary of all boundaries and should come under Group C having no printed symbol, not being marked on the plate and being represented by the same colour as is used for the other working plan boundaries.

5. This necessitates an addition under Group C, and I suggest that the working plan boundaries should be shown as follows :—

Group C (4) Working Circle.

(5) Felling Series.

(6) Coupe.

(7) Sub-compartment.

The sub-compartment cannot be shown as red dots as it would be confused with other standard coloured symbols.

6. The colour given for the boundaries under Group C, items 1, 2, and 3, is too nearly like that for items 4 to 7. After a month in the field they might be indistinguishable Unless it has already a standard meaning I suggest changing this colour to sepia.

7. The third map is the *Working Plan Map* and this is, in many ways, the most important of all. Its scale cannot very well be standardized as that must depend on the intensity of working. In the United Provinces these maps are often on the scale of 1 = 1 mile, and for clearness show no contours. In hilly country, contours on this or the 4″ scale obliterate most other detail.

A working-plan map must show all ordinary details such as roads, blocks, streams, bungalows, etc. In a division where different systems are in force, the areas under the different systems should stand out at a glance on the working-plan map, and it must show in addition (1) working circle boundaries, (2) felling series boundaries, (3) compartment boundaries, (4) sub-compartment boundaries, (5) coupe boundaries, (6) compartment numbers, (7) sub-compartment letters, (8) coupe numbers.

8. It should also show if it is possible species, age, quality, and periodic blocks, though in the case of the last only the 1st 2nd and last periodic blocks need be indicated.

The point is can all items under paras. 7 and 8 be shown on one map?

9. There is no difficulty concerning the items under para. 7, items 1, 2, 4 and 5 being shown by the standard coloured lines, item 3 by the standard symbol, item 5 by a small arabic numeral, item 6 by a small letter against the compartment number, item 8 by a roman numeral, and the other items by their standard symbols without colours.

10. The difficulty comes with the sylvicultural systems and all items under para. 8. To show species by washes is an obvious solution with either age-classes or quality-classes in different shades. This, however, cannot be adopted if everything is to go on one map, because it leaves no easy way of distinguishing systems, a most important point in the U. P. at any rate, and there are too many species in India to find colours for them all.

I find that it is impossible to get more than eight or ten colours which are readily distinguishable to the untrained eye after the map has been in use a month or two and to attempt different shades is quite hopeless.

A survey man will distinguish 30 or 40 different washes, but this is out of the question for the ordinary forest officer.

11. I therefore propose, as a basis for discussion, to distinguish systems by coloured washes, principal species by a symbol above a line, auxiliary species by a symbol below a line, quality by a small roman numeral in brackets, age-class by a small arabic numeral in brackets.

A symbol must be used for undifferentiated "miscellaneous species" and one for forest of mixed age.

First periodic block could be distinguished by a circle round the coupe or compartment number, second periodic block by two circles and last periodic block by a square.

Thus  (I) (20) might mean deodar in mixture with kail, oak and miscellaneous species, deodar predominating, first quality, 20 years old.

XX might mean Coupe XX first periodic block.

6 a might mean sub-compartment 6a last periodic block.

12. The difficulties of this system are the number of symbols necessary for all the important species and the difficulty of remembering them. I understand, however, that symbols can be invented for all species that matter, and in any given province the number to remember would not be excessive, and there is always the reference table on the map.

13. I gather that there may be difficulties about the above in such a place as Nilambur in Madras and possibly in Burma. However, there are many other possible ways, and if the above is not applicable I hope some one will write a reply to this. Even if no system can be standardized for all India, it may still be possible to do so for the vast majority of the forests.

14. If the subject is discussed by the Sylvicultural Conference, a survey man should be present as there are many pitfalls for the unwary

15. A few suggested colours and diagrammatic symbols are attached (*vide* Plate 25).

16. Under para. 11 I have suggested symbols for species. At present I am using letters for species, a capital letter for predominating species above a line, and a small letter below a line for auxiliary species. This is very simple and easy for one division and could probably be adopted for a whole province, but could not well be carried out for all India. It would not create confusion, however, if each province adopted its own meaning for various letters.

S. H. HOWARD, I.F.S.

12*th June* 1919.

ADDITIONAL SYMBOLS AND COLOURS FOR WORKING PLAN MAPS.

SYLVICULTURAL SYSTEMS.

Uniform system (including strip system, group system etc.)

Selection system

Clear cutting system

Coppice with standard system

Coppice system

Improvement felling system

Unworked areas

SPECIES.

	Predominant.	Auxiliary.		Predominant.	Auxiliary.
Deodar			or	D	d
Kail				K	k
Spruce				S	s
Silver-Fir				F	f
Oak				O	o
Sal				Sa	sa
Miscellaneous, etc., etc.	M	m		M	m

QUALITY CLASSES.

First quality	(I)
Second "	(II)
Third "	(III)

AGE (AVERAGE.)

If more or less even-aged	(25)
If irregular	(Ir)

PERIODIC BLOCKS.

First	XIX
Second	XIX
Last	$\boxed{XIX}$

OTHER SYMBOLS.

Coupe number	XX
Compartment	8
Subcompartment number & letter	8b

Copy of letter No. 1240, *dated Dehra Dun, the 24th March* 1919, *from Colonel G. P. Lenox Conyngham, R.E., F.R.S., Superintendent of the Trigonometrical Survey, to the Inspector-General of Forests.*

I have the honour to enclose a copy of a table of symbols which it is proposed to use for forest maps, and would suggest that the proposal might perhaps be considered by the Board of Forestry which is shortly due to assemble.

Forty copies of the symbol table are sent separately in case you should care to distribute them to members of the Board and other Forest Officers.

2. The proposed symbols comprise only such items as are required for use on forest maps and which are not provided for in the list of conventional signs of the Survey of India. (I enclose a copy of the letter in case you should wish to refer to it.)

3. The object in view is to standardize the symbols and thereby to facilitate both the preparation and the reading of forest maps. The principles underlying the proposals are—(*i*) that the Survey of India symbols should be accepted, and (*ii*) that the number of additional symbols should be a minimum.

4. The black, pen-drawn, symbols in group (A) of the proposed list and the first and fifth items in group (B) are those employed in the Survey of India, the size depending on the scale of the map, the style remaining constant. The remaining symbols in group (B) and those in group (D) will, it is hoped, meet the special requirements of all forest maps. No black symbol has been provided in group (C) as these items will be conterminous with one or other of those in groups (A) or (B).

5. The colours proposed are :—

(*i*) For fiscal boundaries, a colour approximating to a neutral tint, *viz.*, Indigo.

(*ii*) For forest boundaries, the colours generally used, *i.e.*, Green and Yellow for the boundaries of Reserved and Protected forests, respectively.

(*iii*) For the limits of forest administration, a fairly prominent colour, *viz.*, Burnt Sienna.

(*iv*) For working-plan boundaries, a vivid colour, *viz.*, Carmine.

ARBORICULTURE IN INDIA.

We publish a press communiqué issued by the Local Administration of the Central Provinces on the important subject of tree planting along public roads.

The policy therein enunciated is of the greatest importance to India as a whole, and we think that the appointment of an officer of the Forest Department to advise upon and supervise arboricultural operations is one which should go a long way to establish and restore the roadside avenues, which are of such importance in this country and which appear to us to have received less attention of recent years than they deserve.

We were under the impression that the Punjab Government, some time ago, had taken steps to place the services of two forest officers at the disposal of the Public Works Department to deal with the problems which have arisen in that province, but doubtless the present shortage of staff has precluded immediate action being taken.

The importance of arboriculture is not limited to roadside avenues, a great deal can be done along canals and in civil stations, cantonments, municipalities, etc., to improve the general amenities of life and the utilization of the soil to best advantage. It is only by a competent agency that the work can be established on sound principles; thereafter continuity of action will alone achieve the desired results. We, therefore, commend the action of the Central Provinces Administration to all interested in this subject, but we would go even further and suggest that provision be made in the forest cadre of each province for the necessary superior staff to deal with this subject of arboriculture. By this means the Forest Department would always be in a position to place at the disposal of canal or road engineers a competent whole-time staff to initiate and control the work. We think, however, that the best results would be attained by placing such officers wholly under the control of the Public Works Department, as the administrative officers of the Forest Department are not in a position to look after arboricultural work in addition to their own.

AGRICULTURE DEPARTMENT, C. P.

Nagpur, the 4th June 1919.

PRESS COMMUNIQUE.

The Chief Commissioner has observed during his tours that much public money has been wasted in the past on tree-planting on public roads owing to the staff of the Public Works Department and of local bodies having an insufficient knowledge of the suitability of different kinds of trees for different soils and localities. Failure has often resulted also through ignorance of proper methods of planting and tending trees in their early years. The Manual of Arboriculture of the Central Provinces and Berar has recently been revised and widely distributed to all interested. For this revision the Administration has to thank Rao Bahadur Shrinivasulu Nayadu, M.B.E., at present Divisional Forest Officer, Seoni, who, when Divisional Forest Officer, Nagpur-Wardha, made a special study of the subject of arboriculture and achieved much success in tree-planting in the neighbourhood of Nagpur. He has incorporated in the Manual the fruits of his practical experience and the new edition should prove much more useful than the earlier ones.

The Chief Commissioner feels, however, that much good would result if Mr. Nayadu were to meet those engaged in the work of arboriculture and discuss his methods with them personally. Sir Benjamin Robertson has, therefore, decided to place him on special duty for a short period to visit district headquarters and to give instruction to the officers and subordinates of the Public Works Department and to the Engineering staff of local bodies on the subject of the wayside tree-planting and tending. It is hoped that this instruction will lead to public funds being utilized to better advantage in the future than in the past. Though Mr. Nayadu's primary duty will be to assist the officers mentioned above, the Chief Commissioner is also prepared that he should give advice to private individuals, such as large landowners, who are interested in arboriculture. Should any such desire to obtain the benefit of Mr. Nayadu's knowledge and experience, they

should address the Deputy Commissioner of the district, who will arrange with Mr. Nayadu, previous to his visit, as to the time and place at which he will give instruction to persons desiring it.

J. F. DYER,
Third Secretary to the Chief Commissioner, Central Provinces.

RAILWAYS AND FOREST FIRES

Railway locomotives offer a very common source of forest fires, not only in the tropics but wherever such lines traverse or run alongside forests. Obviously, the methods of prevention employed in connection with other sources of fire are ineffective against this source; even fire-lines have to be modified to meet the special conditions.

The law in Great Britain is very defective in this respect, and it is certain that more stringent enactments will be passed in due course as forestry is more seriously and extensively practised in the United Kingdom. The Railway Fires Act of 1905 merely makes a railway company responsible for damage proved against it to a limit of £100 (= Rs. 1,500).

It seems very doubtful whether a railway company could be mulcted in damages under the Indian Forest Act for any fire caused by its locomotives and this is a very serious defect in the law. It is within the knowledge of many Forest Officers in India that the engine staff of running trains have been seen throwing burning waste into the scrub alongside the permanent way with the deliberate intention of causing a fire. It is, of course, very rarely possible to prove such mischief, but it is not difficult to prove that constant fires are caused by sparks from locomotives during the dry season.

It is pleasing to foresters to find that the Canadian Government has made a real effort to tackle the problem of protection against forest fires originating from railways in statesmanlike manner and that the fairly stringent clauses of the Railway Act of 1906 (chap. 37), as amended in 1911 (chap. 22), are being worked up to.

Although it is not quite possible to apply all the provisions of this Canadian Law in India at present, there is no reason why some should not be introduced at once. In course of time, no doubt, all would be applicable. The following extracts, therefore, from "Forest Protection in Canada, 1912*":—

"From the beginning of railway legislation in Canada it has been recognized that the operation of coal-burning locomotives is a source of fire damage to adjacent property interests. The original Railway Act of 1903 contained definite recognition of the principle that railway companies must themselves bear the burden of protecting the public against fire loss due to railway operation. The extension of the application of this principle has been gradual but steady, until at the present time the provisions of the Railway Act and of the regulations issued under them comprise the most extensive and the most efficient provisions to be found on this continent for the prevention and control of railway fires by the railways themselves."

The Act gives power to the "Board of Railway Commissioners for Canada" to make orders and regulations for—

(1) the use of fire-protective appliances on locomotives;

(2) the establishment and maintenance of fire-rangers for special patrol work including equipment for fighting fires and rapid transport along the line of railway;

(3) the kind of locomotive fuel to be used;

(4) the clearing of both sides of the railway line of unnecessary combustible matter (including the eradication of noxious weeds);

(5) the financial responsibility for fire loss due to locomotives (if the railway has not been guilty of any negligence, the total amount recoverable must not exceed five thousand dollars = Rs. 15,000, otherwise it is liable to pay the full loss, deducting any sum recovered by the owner of the forest through insurance);

* By C. Leavitt, M. Sc. F., Chief Forester and Chief Fire-Inspector, Board of Railway Commissioners, Canada. Printed at the Bryant Press, Toronto, 1913, with 23 plates. The book contains other information of interest to foresters and is well worth reading.

(6) the construction and maintenance of fire traces (" fire guards ") ;

and all this *at the expense of the railway company.*

The first Act of 1900 having proved insufficient, a new Act was passed in 1906. The provisions, however, were not strictly enforced, and it appears that the Board of Commissioners had not utilized their powers to issue regulations until, in 1909, the Government of British Columbia applied to them " to provide additional and adequate protection from railway fires to the great forest resources of that Province." It was shown that " the use of fire-protective appliances on locomotives, as required by the 1907 order of the Board, while highly essential, did not provide sufficient protection." This application was based on the report of the " Royal Commission of Inquiry on Timber and Forestry," from which was quoted : " It is a truism that railways are the most frequent cause of fire in any timber areas through which they pass. The great majority of witnesses examined by us were somewhat emphatic upon this point."

As a result the following orders and regulations were issued by the Board :—

" ....

' 2. Until further orders every railway subject to the legislative authority of the Parliament of Canada, under construction or being operated by steam, shall, unless exempted by a special order of the Board, cause every locomotive engine used on the said railway, or portion of railway, being constructed or operated by it, to be fitted and kept fitted with netting mesh as hereinafter set forth, namely :—

(*a*) On every engine equipped with an extension smoke-box the mesh shall not be larger than $2\frac{1}{2} \times 2\frac{1}{2}$ per inch of No. 10 Birmingham Wire gauge, and shall be placed in the smoke-box so as to extend completely over the aperture through which the smoke ascends, the openings of the said mesh not to exceed $\frac{1}{4}$ of an inch and 1/64 (that is 17/64) of an inch to the square,

(*b*) On every engine equipped with a diamond stack, the mesh shall not be more than 3 × 3 per inch of No. 10 B. W. G., and shall be placed at the flare of the diamond of the stack, so as to cover the same completely, the openings of the said mesh not to exceed 3/16 and 1/64, *i.e.*, 13/64 of an inch to the square.

"3. Every such company shall cause—

(*a*) the openings of the ash-pans on every locomotive engine used on the railway, or portion of railway, operated or being constructed by it, to be covered, when practicable, with heavy sheet iron dampers; and if not practicable, with screen netting dampers 2½ × 2½ per inch of No. 10 B. W. G. ....;

(*b*) overflow pipes .... to be put into the front and back part of the ash-pans and used from the first day of April to the first day of November......for wetting ash-pans.

"4. Every such railway company shall provide inspectors at terminal or divisional points where its locomotive engines are housed and repaired; and cause them... ..:—

(*a*) To examine, at least, once a week—

(1) the nettings,

(2) Dead Plates;

(3) Ash-pans;

(4) Dampers;

(5) Slides; and

(6) any other fire-protective appliance or appliances used on any or all engines running into the said terminal or divisional points.

(*b*) To keep a record of every inspection in a book to be furnished by the railway company for the purpose showing—

(1) the numbers of the engines inspected;

(2) the date and hour of day of such inspection;

(3) the condition of the said fire protective appliances and arrangements; and

(4) a record of repairs made in any of the above-mentioned fire-protective appliances.

The said book is to be open for inspection by the Chief Fire Inspector or other authorized officer of the Board

(c) In case any of the said fire protective appliances are found to be defective, the locomotive shall be removed from service and shall not be returned to service (during the said prescribed period) unless and until such defects are remedied.

(d) Every such railway shall also appoint one or more special Inspectors, as may be needed, whose duties shall be to make an independent examination of the fire-protective appliances on all the locomotives of such company, at least once each month, and report the condition of such fire-protective appliances direct to the chief mechanical officer of the railway company or other chief officer held responsible for the condition of the motive power of the said company.

"5. Any authorised officer of the Board shall have power to inspect, at any time, any and all locomotives, and may remove from service any locomotive which is found to be defective in the said fire protective appliances; and any such locomotive so removed from service shall not (during the said prescribed period) be returned to service, unless and until such defects are remedied.

"6. No employee of any such railway company shall—

(a) do, or in any way cause, damage to the netting on the engine smoke-stack or to the netting in the front end of such engine;

(b) open the back dampers of such engine while running ahead, or the front dampers while running tender first;

(c) or otherwise do or cause damage or injury to any of the fire protective appliances on the said engine.

"7. No such railway company shall permit fire, live coals, or ashes, to be deposited upon its tracks or right-of-way outside of the yard limits, unless they are extinguished immediately thereafter.

"8. No such railway shall burn lignite coal on its locomotive engines as fuel for transportation purposes, unless otherwise ordered by the Board,—lignite coal consisting of and including all varieties of coal between peat and bituminous with a carbon-hydrogen ratio of 11·2 or less, such ratio being based on analysis of air-dried coal.

"9. Every such railway company shall establish and maintain fire-guards along the route of its railway as the Chief Fire Inspector may prescribe. The nature, extent, establishment and maintenance of such fire-guards shall be determined as follows:—

(*a*) The Chief Fire Inspector shall each year prepare and submit to every such railway company a statement of the measures necessary for establishing and maintaining the routes of such railways in a condition safe from fire, so far as may be practicable.

(*b*) Such measures may provide for the cutting and disposal by fire, or otherwise, of all or any growth of an inflammable character, and the burning or other disposal of débris and litter, on a strip of sufficient width on one or both sides of the track, the ploughing or digging of land in strips of sufficient width on one or both sides of the track and such works as may, under the existing and local conditions and at reasonable expense, tend to reduce to a minimum the occurrence and spread of fire.

(*c*) Such statements of the Chief Fire Inspector shall be so arranged as to deal with and prescribe measures for each separate portion of such railway upon and adjacent to which the fire risk calls for specific treatment. The intention shall be to adjust the protective measures to the local conditions and to make the expense proportionate to the fire risk and the possible damage.

(*d*) Such statements of the Fire Inspector shall prescribe dates on which or within which the foregoing protective measures shall be commenced and completed, and the fire guards maintained in a clean and safe condition.

(*e*) No such railway company shall permit its employees, agents or contractors to enter upon land under cultivation to construct fire-guards, without consent of the owner or occupier of such land.

(*f*) Whenever the owner or occupier of such land objects to the construction of fire-guards, on the ground that the said construction would involve unreasonable loss or damage to the property, the company shall *at once* refer the matter to the Board, giving full particulars thereof and shall in the meantime refrain from proceeding with the work.

(*g*) No agent, employee or contractor of any such railway company shall permit gates to be left open or to cut or leave fences down whereby stock or crops may be injured, or do any other unnecessary damage to property in the construction of fire-guards.

"10. In carrying out the provisions of section 297 of the Railway Act, which enacts that "the company shall at all times *maintain and keep its right-of-way free from dead or dry grass*, weeds and other unnecessary combustible matter," no such railway company or its agents, employees or contractors shall, between the 1st day of April and the 1st day of November, burn or cause to be burnt any ties (= sleepers), cuttings, débris or litter upon or near its right-of-way, except under such supervision as will *prevent such fires from spreading beyond the strip being cleared.* The Chief Fire Inspector or other authorized officer of the Board may require that no such burning be done along specified portions of the line of any such railway, except with the written permission as under the direction of the Chief Fire Inspector or other authorized officer of the Board.

"11. *The railway company shall provide and maintain a force* of fire-rangers fit and sufficient for efficient patrol and fire-fighting duty during the period from the 1st day of April to the 1st day of November of each year; and the methods of such force shall be subject to the supervision and direction of the Chief Fire Inspector or other authorized officer of the Board.

"12. The Chief Fire Inspector shall, each year, prepare and submit to each and every railway company a statement of the measures such railway companies shall take for the establishment and maintenance of said specially organized force. Said statements among other matters may provide for—

(*a*) the number of men to be employed on the said force, their location and general duties, and the methods and frequency of the patrol;

(*b*) the acquisition and location of necessary equipment for transporting the said force from place to place, and the acquisition and distribution of suitable fire-fighting tools; and

(*c*) any other measures which are considered by him to be essential for the immediate control of fire and may be adopted at reasonable expense.

"13. Whenever and while all the locomotive engines used upon any such railway, or any portion of it, burn nothing but oil as fuel during the aforesaid prescribed period, under such conditions as the Board may approve, the Board will relieve the said railway of such portions of these regulations as may seem to it safe and expedient.

"14. The section men and other employees, agents and contractors of every such railway company shall take measures to report and extinguish fires on or near the right-of-way, as follows:

(*a*) Conductors, engineers or train men who discover or receive notice of the existence and location of a fire burning on or near the right-of-way, or of a fire which threatens land adjacent to the right-of-way, shall report the same to the agent or persons in charge at the next point at which there shall be communication by telegraph or telephone, and to the first section employees passed. Notice of such fire shall be also given immediately by a system of warning whistles.

(*b*) It shall be the duty of the agent or person so informed to notify immediately the nearest Forest Officer and the nearest section employees of the railway, of the existence and location of such fire.

(*c*) When fire is discovered, presumably started by the railway, such section men or other employees of the railway as are available shall either independently or at the request of any authorized Forest Officer proceed to the fire immediately and take action to extinguish it; provided such section men or other employees are not at the time engaged in labours immediately necessary to the safety of trains.

(*d*) In case the section men or other employees available are not a sufficient force to extinguish the fire promptly, the railway company shall, either independently or at the request of any authorized Forest Officer, employ such other labourers as may be necessary to extinguish the fire; and as soon as a sufficient number of men other than the section men and regular employees are obtained the section men and other regular employees shall be allowed to resume their regular duties.

NOTE.—Any fire starting or burning within 300 feet of the railway track shall be presumed to have been started from the railway unless proof to the contrary is furnished.

"15. Every such railway company shall give particular instructions to its employees in relation to the foregoing regulations and shall cause appropriate notices to be posted at all stations along its lines of railway.

"16. Every such railway company allowing or permitting the violation of, or in any respect, contravening or failing to obey any of the foregoing regulations, shall, in addition to any other liability which the said company may have incurred, be subject to a penalty of one hundred dollars (= Rs. 300) for every such offence.

"17. If any employee, or other person included in the said regulations, fails or neglects to obey the same, or any of them, he shall, in addition to any other liability he may have incurred, be subjected to a penalty of twenty-five dollars for every such offence."

The Chief Fire Inspector took action on this order without delay as the railway companies were already proceeding with plans for fire-guard (fire-traces) construction, his attention was directed

particularly to instituting an efficient system of patrols under regulations 11 and 12. In framing his instructions he was guided by the following considerations :—" Under ordinary conditions of grade and traffic, each patrolman was required to be equipped with a velocipede (hand speeder), where the fire danger was great, each man was required to make two round trips per day over his beat, which consisted of from 6 to 15 miles of track according to conditions. Where one round trip per day would suffice, the length of the patrol district was extended correspondingly. On the heaviest grades only foot-patrols were practicable, these covering from 5 to 10 miles of track each. Where the train traffic was light as on some of the lines in Southern British Columbia, and elsewhere, it was found practicable to prescribe patrols by power speeder. In this case the patrol district varied from 20 to 50 miles, according to conditions. Power speeders are, however, not practicable for patrol where there is much train traffic, on account of the danger to the patrolman. So far as practicable, track-walkers and bridge and tunnel watchmen were utilized on special patrol work, thus materially decreasing the cost to the railway company."

Extracts from the instructions will show their completeness and that the matter was taken up seriously.

" You are hereby notified that in accordance with the provisions of Order 16570 of the Board of Railway Commissioners you are required to establish upon such portions of the Canadian Pacific Railway and of the lines under its control as are hereinafter described, a force of fire-rangers fit and sufficient for efficient patrol and fire fighting duty during the period from April 1st, 1913, to November 1st, 1913, except in so far as you may be relieved in writing from such patrol by the Chief Fire Inspector or other authorized officer of the Board.

Patrols.—The details of the patrols required are as follows, it being understood that unless otherwise specified the patrol shall be continuous between the hours of seven in the morning and six in the evening of each day, including Sundays, with a minimum patrol so far as possible of two round trips per day, one in the forenoon and one in the afternoon.

....

British Columbia Division.

District No. 1.

On the Mountain Sub division (between Field and Revelstoke, 130·3 miles) the Shuswap Sub-division (between Revelstoke and Kamloops, 129·1 miles) the Okanagan Sub division (between Sicamons and Okanagan Landing, 50·8 miles) and on the Arrow Lake Sub-division (between Revelstoke and Arrowhead, 27·4 miles) the patrol and fire-fighting work shall be done by the regular force of section men, track-walkers, and watchmen, with a minimum patrol of one round trip per day, including Sundays. No special patrol is required between Chase and Kamloops on the Shuswap Sub-division, and between Mara, Okanagan Landing on the Okanagan Sub-division. The above is based on the assumption that oil will be used exclusively as locomotive fuel during the fire-season, and that the right of way will be maintained in a condition free from inflammable material, as required by section 297 of the Railway Act Should either of these conditions not be fulfilled to the satisfaction of the Fire Inspector for the Railway Belt, additional measures will be prescribed by him and may include any of the special measures relating to the above portion of your line enumerated in my letter to the Company, dated June 15th, 1912. In particular, a special patrol shall be provided by the Company, following 30 minutes after any coal-burning locomotive passing over any portion of district No. 1 in the daytime.

Special attention is required on the part of the Company with regard to clearing the right-of-way, since there is a considerable amount of inflammable material along some portions of the line where the danger of fire from sources other than locomotives will necessitate special patrols unless said section 297 is strictly complied with. This matter is under consideration by the Board and will be made the subject of a separate letter.

District No. 2.

(1) *Thompson Sub-division.*—Between Drynoch and North Bend, 42·3 miles, the patrol and fire-fighting works shall be done

by the regular force of section men, track-walkers and watchmen; minimum patrol of two round trips per day, including Sundays

....

(3) *Cascade Sub-division.*—Between North Bend and Waleach, 53·4 miles, four men with velocipedes, distributed as follows:—

Between North Bend and mileage 14, 14 miles;
Between mileage 14 and Yale, 13·1 miles;
Between Yale and Hope, 13 miles;
Between Hope and Waleach, 13·3 miles.

Should the right-of-way not be cleared to the satisfaction of the Fire Inspector for the Railway Belt, such additional measures shall be taken as shall be prescribed by such Fire Inspector.

Whenever oil shall be used exclusively as locomotive fuel on any portion of the above lines, and satisfactory compliance with section 297 of the Railway Act shall have been secured, relief will be granted in whole or in part from the above special requirements, upon application to the Fire Inspector of the Railway Belt.

District No. 3.

....

Between Castlegar and Shields, 13·3 miles, one man with velocipede.

Between Shields and Mile Point 41·8, 2·8 miles, one foot patrolman who may also be bridge watchman.

Between Mile Point 41·8 and Mile Point 50, 8·2 miles, one foot patrolman.

Between Mile Point 50 and Mile Point 55, 5 miles, one man with velocipede, who may also be bridge watchman.

....

GENERAL PROVISIONS.

So far as practicable, the work of patrol has been combined with the other regular duties of the employees, but where this action has not been specifically indicated the patrol force is to be a specially organized and specially supervised body of men, who shall perform, to the exclusion of other duties, the patrol and other fire-protective work indicated in the Regulations of the Board and specified herein.

In every case where special or section patrols are required, special instructions must be issued and special supervision must be provided by the company.

As a matter of record, velocipede patrolmen passing telegraph stations shall be reported the same as passing trains and such records shall be freely open to the inspection of any authorized officer of the Board.

Each foot patrolman shall be equipped with one shovel and one canvas bucket. Each velocipede patrolman shall be equipped with 2 shovels, 2 canvas buckets and one axe. In addition to the above, and to the regular section equipment, there shall be stored at the tool house for each section and each patrol district the following emergency fire-fighting equipment: one axe, 3 mattocks and 4 buckets of not less than 12 quarts capacity each. Equipment for the transportation of patrolmen will also be furnished by the company as indicated."

....

Finally the following draft instructions to be issued by the several railway companies to their employees were framed :—

"To Enginemen, Conductors, Brakemen and Firemen:

It shall be the duty of train and engine crews on freight and passenger trains, when discovering a fire, on or adjoining the right-of-way of the Railway Company, to stop and use every effort to extinguish such fire. In the event of this being impracticable, either by reason of the extent of the fire or its distance from the right-of-way, the train shall proceed to the first telegraph station, where the conductor shall wire a report to the Superintendent, giving the exact location of the fire, and the action taken by engine and train crew concerning the same. It shall also be the duty of the enginemen to stop and notify the first section gang passed, regarding any fire not extinguished as above.

No employee shall do or cause damage or injury to any of the fire-protective appliances on any engine; open the back dampers of any engine while running ahead, or the front dampers while running tender first, or permit fire, live coals or ashes to be

deposited on tracks or rights of-way outside of yard limits unless the same are extinguished immediately thereafter.

To Agents:

The enginemen and conductors of all trains have received instructions to report fire along the right-of-way and adjacent thereto, and it shall be your duty to notify the local Fire Inspector of the Railway Commission immediately, giving the exact location of the fire and its extent, and forthwith wire the Superintendent, giving the location of the fire, the extent of the same, and any other information which may be of value particularly as to the number of men needed to extinguish the fire.

To Roadmasters, Assistant Roadmasters, Master Carpenters and other officials:

In cases where fires are reported, it shall be the duty of any divisional official to proceed to the scene of the fire as quickly as possible and to take charge of the work of fire fighting until he can be relieved by the Division Roadmaster. The man first on the ground should organize his men to do the best work possible and when this is done, he should immediately proceed to investigate the origin of the fire, and fix the location where it started; get statements from all witnesses, and make every effort to learn the origin and fix the responsibility. The law, as now interpreted, practically makes this company responsible for fires starting within 300 feet of the track, unless it can be shown that the company is not responsible. It is necessary, therefore, to determine positively the origin, in order to relieve the Railway Company of the responsibility. The first officer on the ground should endeavour to hold a joint investigation with the local Fire Inspector of the Railway Commission, or other local forestry officer, and agree upon the origin of the fire. This will avoid disputes later on.

To Chief Despatchers:

In all cases where fires are reported, it will be the duty of the despatcher to get full information as to the extent of such fire, its location, and the number of men necessary to fight it. It will also be the duty of the despatcher to furnish whatever train service may be required to move extra gangs, section gangs, or bridge crews, to

the fire immediately, giving this movement preference if the emergency requires it.

To Section men, Extra Gangs and Bridge Foremen:

In all cases where fire occurs, it shall be the duty of all section crews, extra gangs and bridge crews to proceed immediately to such fires, and extinguish the same, remaining as long as may be necessary to do this; and it must be understood that this is the most important work that can be done, and that the carrying on of your work, though it may be important, must be set aside until the fire is extinguished. The section foreman, on whose section the fire occurs, shall, in the absence of an official of the company, make a thorough investigation regarding the origin of the fire, and submit a full report to the Roadmaster.

Between April 1st and November 1st no ties, cuttings, débris or litter upon or near the right-of-way shall be burned, except under such supervision as will prevent such fire from spreading beyond the strip being cleared. Officers of the Railway Commission may require that no such burning be done along specified portions of the line, except with the written permission or under the direction of such officer.

During the fire-season of 1912 two hundred fires were reported as starting within 300 feet of the tracks of railways under the jurisdiction of the Railway Board, which burned over 25,148 acres; these figures do not include prairie fires. These fires are classified as follows :—

Cause.	No. of fires.	Kind of land burnt over.	Acres.	Property destroyed.	Value.	
					Dollars.	Rs.
Trains	164	Grass or cultivated land ..	4,135	Young growth ..	51,655	1,54,965
Camp and casual fires ..	12	Young forest growth ..	17,017	Standing timber .	17,175	51,525
Unknown ...	24	Timber land ..	1,322	Forest products in process of manufacture ...	650	1,950
		Slashing or old burn not re-stocking ...	2,674	Railway property not covered in above ..	18,250	54,750
				Other private property ..	750	22,50
Total ..	200		25,148		88,480	2,65,440

Undoubtedly some of the measures detailed above could be introduced at once and many of the others later on. It is for Forest Officers to urge the necessity on the authorities, where the danger is greatest.

April 1919.

C. FISCHER, I.F.S

THE FOOD PLANTS OF INDIAN FOREST INSECTS.

BY C. F. C. BEESON, M.A., I.F.S., FOREST ZOOLOGIST.

PART IV.

(*Continued from* Indian Forester, *pp.* 312—323.)

LAMIIDÆ.

Apomecyna histrio, Fabr.

Borer.—*Tinospora cordifolia.*[38]

Distribution.—[India ; Malaya.]

Apriona cinerea, Chev.

Bark eater and girdler.—*Morus indica.*

Heartwood borer.—*Morus indica.*

Distribution.—[New Guinea] ; Siwaliks, U. P.

Apriona germari, Hope.

Bark eater and girdler.—*Ficus infectoria, Morus indica.*

Heartwood borer.—*Morus indica. Morus alba,*[44] *Broussonetia papyrifera.*[44]

Distribution.—[Sylhet] ; Lahore, Punjab, Mussoorie, Almora, Siwaliks, U. P.; Tonkin.

Apriona rugicollis, Chev.

Wood borer.—*Morus alba.*[49]

Distribution.—[Japan ;[49] Burma.]

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[38] Lefroy, 1910, p. 153.

[44] Duport, 1913, p. 989.

[49] Bureau of Agriculture, Tokyo, 1913.

Aristobia approximator, Thoms.

Bark girdler.—*Lagerstrœmia Flos-Reginæ.*

Borer.—*Anona* sp.[41]

Distribution.—[Malaya]; Sylhet, Sibsagar, Khasias, Assam Southern Shan States.

Aristobia birmanica, Gahan.

Bark girdler.—*Lagerstrœmia Flos-Reginæ.*

Wood borer.—*Tectona grandis.*

Distribution.—[Karen and Kachin Hills, Bhamo, Rangoon]; Katha, Shwegu, Tharrawaddy, Pyinmana, Burma.

Batocera albofasciata, De Geer.

Heartwood borer.—*Castilloa elastica*,[42] *Erythrina indica*,[42] *Ficus elastica*, *Ficus hispida*[42].

Distribution.—[Indo-Malaya.]

Batocera roylii, Hope.

Heartwood borer.—*Mangifera indica.*

Distribution.—[India]; Siwaliks, U. P.; Shillong, Assam.

Batocera rubus, Linn.

Shoot girdler.—*Albizzia Lebbek*,[43] *Hevea brasiliensis*,[47] *Moringa pterygosperma.*[48]

Heartwood borer.—*Bombax malabaricum*, *Erythrina indica*, *Ficus carica*, *Ficus elastica*,[49] *Ficus glomerata*,[50] *Mangifera indica.*

Distribution.—[Indo-Malaya; Africa; Mauritius, West Indies, etc.].

Batocera titana, Thoms.

Heartwood borer.—*Mangifera indica.*

Distribution.—[India]; S. Shan States, Karen Hills.

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41 Fletcher, 1917, B, p. 257.

42 Dammerman, 1913, p. 33.

43 De Charmoy, 1914.

47 Dupont, 1913, Henry, 1915, Green, 1916, and Fletcher, 1917, b, p. 36.

48 Fletcher, 1917, B, p. 299.

49 Ballou, 191 .

50 Fletcher, 19 6, p. 10

Cœlosterna scabrator, Fabr.[54]

Bark eater and girdler.—*Casuarina equisetifolia, Shorea robusta.*

Heartwood borer.—*Acacia arabica, Casuarina equisetifolia.*[51]

Distribution.—[India.]

Cœlosterna spinator, Fabr.[54]

Bark eater.—*Pyrus Malus,*[52,53] *Rosa* sp.[52,53]

Heartwood borer.—*Acacia arabica,*[52] *Casuarina equisetifolia,*[52] *Zizyphus Jujuba*[53].

Distribution.—[India.]

Coptops ædificator, Fabr.

Heartwood borer.—*Amoora Rohituka, Bauhinia Vahlii, B. variegata, Buchanania latifolia, Garuga pinnata, Odina Wodier, Shorea robusta, Spatholobus Roxburghii.*

Distribution.—[India ; Ceylon ; Java ; Africa.]

Dihammus fistulator, Germar.

Heartwood borer.—*Coffea* sp.,[55] *Ficus elastica,*[55] *Theobroma Cacao.*[55]

Distribution.—[India ; Ceylon ; Malaya ; Andamans.]

Epepeotes luscus, Fabr.

Heartwood borer.—*Artocarpus integrifolia,*[55] *Castilloa elastica,*[55] *Ficus hispida,*[55] *Mangifera indica, Theobroma Cacao.*[55]

Distribution.—[Burma ; Siam ; Malacca ; Borneo ; Java ; Sumatra.]

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54 Confusion appears to exist between *Cœlosterna scabrator*, Fabr. [Sp. Ins., I, p. 224 (1781)] and *C. spinator*, Fabr. [Suppl. Ent. Syst., p. 145 (1798)]. Stebbing, 1914, relying on an identification by Gahan considers *spinator* as a variety of *scabrator*. Lefroy, 1909, and Fletcher, 1914, treat the two as distinct species. The Research Institute collection contains specimens of each species with various host records, but as the authority for identification is unreliable I have omitted them in this list.—C. F. C. B.

51 Fletcher, 1914, p. 326.

52 Fletcher, 1914, p. 325.

53 Fletcher, 1917, B, p. 254 ; p. 265.

55 Dammerman, 1913, p. 33.

Epepeotes uncinatus, Gah.

Heartwood borer.—*Ficus elastica.*

Distribution.—[Karen Hills, Burma; Assam, Sikkim]; Tista, Bengal.

Glenea galathea, Thoms. Var. Nov.

Sapwood borer.—*Gmelina arborea, Tectona grandis.*

Distribution.—[Japan]; Myitkyina, Katha, Burma; Kanara, Bombay.

Glenea indiana, Thoms.

Sapwood borer.—*Tectona grandis.*

Distribution.—[India]; Sikkim, Khasias, Assam; Pyinmana, Tharrawaddy, Karen Hills, Burma.

Glenea 14—maculata, Hope.

Sapwood borer—*Pinus excelsa, Pinus longifolia.*

Distribution.—[Sylhet]; Rawalpindi, Kangra, Punjab; Chakrata, Almora, Naini Tal, Garhwal, Siwaliks, U. P.

Glenea multiguttata, Guer.

Sapwood borer.—*Boswellia serrata, Odina Wodier.*

Distribution.—Belgaum, Kanara, Bombay; Bangalore Madura, Madras; Chindwara, C. P.

Glenea spilota, Thoms.

Sapwood borer.—*Bombax malabaricum.*

Distribution.—[Burma; India]; Siwaliks, Kheri, U. P.; Jalpaiguri, Bengal; N. E. Frontier, Assam.

Haplohammus cervinus, Hope.

Heartwood borer.—*Tectona grandis.*

Distribution.—[Japan; China; Assam; Nepal; N. India]; Karen Hills, Myitkyina, Katha, N. Shan States, Pyinmana, Toungoo, Burma.

Haplohammus punctifrons, Gahan.

Heartwood borer.—*Ficus elastica.*

Distribution.—[Karen Hills, Tenasserim]; Lakhimpur, Assam.

Mecotagus tigrinus, Oliv.

Heartwood borer.—*Ficus elastica.*

Distribution.—[India]; Tista, Bengal; Kanara, Bombay.

Moechotypa verrucicollis, Gahan.

Bark-eater.—*Hevea braziliensis* [56].

Distribution.—[Bhamo, Burma; Ceylon]; Siwaliks, U. P.

Monochamus bimaculatus, Gahan.

Heartwood borer.—*Dalbergia Sissoo.*

Distribution.—[Bhamo, Tenasserim, Burma; Siam]; Siwaliks, U. P.; Buxa, Bengal.

Monochamus nivosus, White.

Heartwood borer.—*Calotropis gigantea, Kydia calycina.*

Distribution.—[U. P.; Nepal, Central and Southern India; Burma; Ceylon.]

Nupserha variabilis, Gahan.

Sapwood borer.—*Tectona grandis.*

Distribution.—[Siam; Tenasserim, Karen Hills, Bhamo, Rangoon], Toungoo, Burma.

Olenecamptus bilobus, Fabr.

Sapwood borer.—*Artocarpus blumei, Ficus Carica,* [57] *Ficus elastica, Ficus glomerata, Ficus Roxburghii, Mangifera indica.* [58]

Leaf eater.—*Ficus* spp.

Distribution.—[Sumatra, Java; Siam, Indo-China, Bhamo, Tenasserim]; Siwaliks, U. P.; Bengal; Kanara, Bombay; S. India.

Olenecamptus curvipes, Gahan.

Sapwood borer.—*Anogeissus latifolia.*

Distribution.—Bombay; Kurnool, Madras; Indore; Gonda, U. P.

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[56] Rutherford, 1914, p. 41, and Green, 1916.

[57] Fletcher, 1917, B, p. 251; p. 337.

[58] Dammerman, 1913, p. 33.

Sthenias grisator, Fabr.

Bark-eater and girdler.—*Chloroxylon Swietenia*,[59] *Erythrina indica*,[60] *Morus alba*, *Nerium odorum*,[60] *Rosa* spp., *Tabernæmontana alba*, *Vitis Vinifera*.[60]

Distribution.—[India ; Malaya.]

Xylorrhiza adusta, Wiedm.

Bark-eater and girdler.—*Premna* sp., *Wrightia tinctoria*.

Distribution.—[Madras, Ceylon ; Bhamo, Karen Hills] ; S. Shan States, Toungoo, Burma.

LUCANIDÆ.

Cladognathus giraffa, Fabr.

Borer of decaying wood.—*Picea Morinda*, *Quercus* sp.

Distribution.—Chakrata, Mussoorie, Dehra Dun, Naini Tal, Lansdowne, U. P. ; Darjeeling, Chittagong Hills, Bengal ; Khasia Hills, Assam ; Andamans.

Dorcus antæus, Hope[61]

Borer of decaying wood.—*Quercus incana*.

Distribution.—Naini Tal, U. P. ; Kurseong, Darjeeling, Bengal ; S. Shan States, Burma ;

Eurytrachelus reichei, Hope.[61]

Borer of decaying wood.—*Rhododendron* sp.

Distribution.—Naini Tal, U. P. ; Darjeeling, Kurseong, Jalpaiguri, Bengal.

Hemisodorcus nepalensis, Hope.

Borer of decaying wood.—*Cedrus Deodara*, *Quercus* sp.

Distribution.—Chakrata, Mussoorie, Tehri Garhwal, Almora, Naini Tal, U. P. ; Darjeeling, Kurseong, Bengal.

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[59] Jour. Bom. Nat. Hist. Soc., 1914, XXIII, p. 767.

[60] Fletcher, 1917, B, p. 251 ; p. 337.

[61] D'Abreu, 1915, p. 41, says the "genera *Dorcus* and *Eurytrachelus* are to be found in large numbers in hollow and decaying trees, chiefly "sauer" (*Betula cylindrostachys*), "masre katus" (*Castanopsis tribuloides*) and "kharani" (*Symplocos theæfolia*), in the Darjeeling Himalayas.—C. F. C. B.

Lucanus cantori, Hope.

Borer of decaying wood.—*Betula cylindrostachys,* [62] *Castanopsis tribuloides,* [62] *Symplocos theæfolia.* [62]

Distribution.—Darjeeling, Kurseong, Bengal; Khasia Hills, Assam.

Lucanus lunifer, Hope.

Borer of decaying wood.—*Machilus* sp., *Quercus dilatata, Quercus incana.*

Distribution.—Simla, Punjab; Chakrata, Mussoorie, Dehra Dun, W. Almora, Naini Tal, U. P.; Khasia Hills, Assam.

Lucanus mearssi, Hope.

Borer of decaying wood.—*Symplocos theæfolia.*

Distribution.—Mussoorie, U. P.; Darjeeling, Kurseong, Bengal.

Nigidius distinctus, Parry.

Borer of decaying wood.—*Macaranga pustulata.*

Distribution.—Buxa, Bengal, N. Shan States, Burma

Prosopocoelus budda, Hope.

Borer of decaying wood.—*Picea Morinda.*

Distribution.—Chakrata, Dehra Dun, U. P.; Darjeeling, Bengal.

PASSALIDÆ.

Leptaulax dentatus Fabr. [63]

Borer of decaying wood.—*Bombax malabaricum, Ficus elastica, Shorea robusta.*

Distribution.—[Darjeeling, Buxa, Jalpaiguri, Bengal; Nepal; Bhutan; Goalpara, Lakhimpur, Chittagong Hills; Cachar, Assam; Pegu, Tenasserim, Tavoy, Burma; Andamans; Indo-China; Malaya, etc.].

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[62] Recorded by Stebbing, "Injurious Insects," p. 34, and "Forest Zoology," p. 80, but not in "Indian Forest Insects," 1914; recorded by D'Abreu, 1915, p. 36, apparently on the first authority.—C. F. C. B.

[63] "Leptaulax darjeelingi, Knw," Stebbing, 1914, p. 67.

Ophrygonius cantori, Perch.

Borer of decaying wood.—*Betula cylindrostachys*, *Carpinus viminea*, *Castanopsis tribuloides*, *Machilus odoratissima*, *Quercus* sp., *Symplocos theæfolia*

Distribution.—[Kulu, Punjab, Chakrata, Naini Tal, West Almora, U. P., Tista, Darjeeling, Kurseong, Bengal, Sikkim; Bhutan; Naga Hills, Khasia Hills, Assam; Ruby Mines, Bhamo, Burma; Tonkin.]

Tiberioides kuwerti, Arrow.

Borer of decaying wood.—*Juglans regia.*

Distribution.—[Nepal; Darjeeling, Bengal; Bhutan; Naga Hills, Assam; Burma.]

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RED WOOD OF HIMALAYAN SPRUCE (*PICEA MORINDA*, LINK).

The Himalayan spruce has no true heart-wood but the inner wood is sometimes found to be red in colour and it is often asserted by forest officers that this red wood will not float

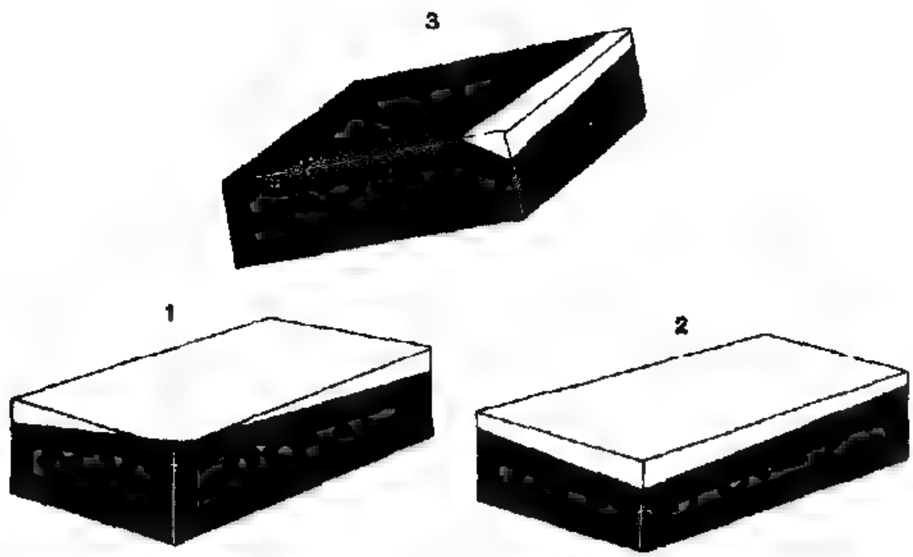
An investigation to discover the cause of this discolouration is now in progress at Dehra Dun, the occurrence of which appears to be analogous in some respects to that of brown oak in Europe, recently reported upon by Prof. P. Groom (*Ann Bot.*, Vol. 29, p. 393, 1915).

The present paper, however, merely deals with a small experiment, which has been recently carried out at Dehra Dun, to test the water-absorbing capacity of white and red spruce wood respectively.

The wood specimens were received from Mr. H. M. Glover, Deputy Conservator of Forests, Bashahr, Punjab.

Three blocks were cut of approximately the same size and shape, and after being weighed were placed in water in a big enamelled basin in the Dehra Dun Laboratory on September 25th, 1918. It was noted at the start that the red blocks, being heavier in weight than the normal white block, sank deeper when put into the water, but at the close of experiment the reverse was the case. The white block which originally floated much higher in the water had now almost entirely sank, while the red blocks had sank very little deeper than at the beginning. The black portions in the figure (Plate 26) represent the parts of the blocks which were below the water surface at the close of the experiment on 5th April 1919.

At the close of the experiment the blocks were re-weighed and re-measured to see if any difference as regards their weights and measurements had taken place after the immersion in water. As regards the measurements, the differences were very slight, but there was a good deal of increase in weight as the following statement shows. The white wood had absorbed the larger quantity of water, and was about three times its original weight. On the other hand, the red blocks absorbed comparatively little water :-



1 and 2 Red blocks. 3 White block.

Black area represents the immersed part.

No. of Blocks.	Weight in grammes.			Measurement in millimeters.			Total cubic contents of wet blocks at close of Expt.	Cubic content of wood above water surface at close of Expt.
	Before putting in water on 25-9-18.	At close of Expt. on 5-4-19.	Difference	Before putting in water on 25-9-18.	At close of Expt. on 5-4-19.	Difference.		
1 Red Block ...	368·7	628	+259·3	153×93·75 ×51	154×95·5× 52·5	+1×1·75 ×1·5	772·12 cc.	124·5 cc
2 Red Block ...	373·2	660	+268·8	153×94× 51·5	154×96·5× 52·25	+1×2·5 ×·75	776·49 cc.	125·5 cc.
3 White Block ...	259·6	760	+500	152·75 × 93·75× 51·25	153×96×52	+·25×2·25 ×·75	763·78 cc.	9·5 cc.

From the above it will be seen that the red wood is heavier, volume for volume, than the normal white wood, but after soaking both specimens in water for the same length of time the white wood becomes much heavier, volume for volume, than the dark wood; hence the water absorbing capacity of the red wood is, in fact, less than that of the normal white wood.

In connection with the above, the following statement by Mr. R. N. Parker (*Forest Flora of Punjab*, 1918, p. 541) is interesting :—

"This brown timber (of spruce) is said by contractors not to float but experiments in floating sawn specimens in a tank made by the Divisional Forest Officer, Chakrata, and by myself showed that the brown timber floats as well as the white."

In the light of these experiments it is hoped that local officers will undertake some further experiments on a larger scale with the object of definitely testing the truth of the local idea as to the red wood not floating.

This work was taken up at the suggestion of Mr. R. S. Hole, Forest Botanist, to whom the writer's best thanks are due.

A. HAFIZ KHAN,
Assistant to Forest Botanist.

5th May 1919.

DOES FIRE, OR EXPOSURE OF TREES GROWING UNDER SHADE, OR DAMAGE TO HOSTS LEAD TO SPIKE DISEASE IN SANDAL.

In the December number of the *Indian Forester*, Mr. Fischer records his observations on sandal saplings burnt on fire-lines at Horsleykonda, a hill rising to 4,322 feet with a rainfall of 30 inches, where the sandal was not indigenous but introduced.

"It seems very doubtful," says Mr. Fischer, "that injury by fire will lead to spike in sandal in a locality where spike does not already exist on that species."

The following observations are made with reference to an area which has a rainfall of about 140 inches and an elevation varying from 50 to 380 feet :—

In Shankernaraina Range of South Kanara District, North Mangalore Forest Division, sandal is indigenous in some of the coupes of the Mavinaguli block and also in the unreserves on both sides of the Neralcatta-Sabladi road.

Coupe No. V of Mavinaguli block was burnt in 1917-18, and in February of 1918-19 and during March of the latter year I inspected the area Twenty-four sandal trees were severely burnt. Again in November 1918, I inspected the coupe as I had orders from the District Forest Officer to extract these trees and send them to Mangalore Depôt. Trees Nos. 8, 11, 14, 17 and 20 had leafy shoots springing from the stem at the bottom, and in no case were there less than three shoots to the stem. Another severely burnt tree, which was not numbered, had sent forth five shoots from the bottom of the stem and two shoots from the stem 2 feet from the bottom.

On inspection of these trees in February 1919, I found the height of the shoots to average 3′6″ and the growth to be very healthy. The stems had been burnt to the extent that the bark had fallen off close to the bottom of the stems except in two cases in which the bark remained to a height of one foot from the bottom ; and the branches were all dead.

In most of the unreserves above referred to, there are annual fires, but so far no case of "spike in sandal" has been observed, and Mr. Fischer's doubt appears to be justified by the facts in this locality.

Another factor which was mentioned in the October number of the *Indian Forester* as a probable cause of spike in sandal was the exposure of trees hitherto grown under shade.

In coupe VII of Mavinaguli block there are about 200 sandal trees of 6″ in girth and above. Most of these trees were growing under heavy shade until 1916-17, the year in which the coupe was worked. Under the method of "coppice-with-standards" an average of 20 standards only was left to the acre including some sandal trees, and all other growth was cut.

Coupe V of the block already referred to above with reference to fire was similarly worked in 1915 16, and in this there are now 302 trees of and over 6″ in girth.

In these cases, although the sandal trees were suddenly exposed no tree has yet shown any signs of spike, and the facts at least in this particular locality do not support the theory that exposure will lead to disease where it does not already exist

Another conclusion suggested by the above facts is that damage to or death of hosts does not necessarily lead to spike disease, since it is evident that in a coupe of about 65 acres in which all growth except 20 standards per acre has been cut back, damage to hosts must necessarily have taken place.

It is perhaps the case that stumps of coppiced trees are more active in spending their stored-up nutriment in the production of shoots than in encouraging the haustoria of sandal roots to parasitise upon them, unless the popular theory of root parasitism of sandal is wrong ; but if injury or damage to hosts in any area is due to fire, wind or general drought, sandal trees thereon must also be affected ndependently of their hosts.

(Sd.) C. KARUNAKARA MENON,

Dated 23rd February 1919. *Forest Range Officer.*

PROVINCIAL FOREST TRAINING SCHOOL, UNITED PROVINCES.

Final Examinations.

The final examination came off as usual in the last week of June 1919 at Naini Tal, the written part of it having been held from 23rd to 25th and oral from 26th to 28th June. The Board of Examiners consisted of Messrs. Oliphant, Marriott, Clifford, Herbert, Deputy Conservators of Forests, and Messrs. Sita Ram Puri and Keshab Datt Joshi, Extra-Assistant Conservators of Forests, and myself All the 30 students who appeared in the examination succeeded in obtaining certificates. Two medals were offered by Government and one prize by the Officer in charge of the School for competition among the students and these were awarded as follows :—

(1) Medal for the "First student in the Class" to Tulsi Ram Bahuguna, Forester, South Garhwal Forest Division.

(2) "Forestry Medal" for the "First student in Sylviculture in the class" to Tulsi Ram Bahuguna.

(3) "Prize for merit" to Trivikram Singh, Forester, North Garhwal Forest Division.

Certificates and prizes were distributed to the students by Mr. Leete, Chief Conservator of Forests, U. P., on 2nd July 1919, and very instructive speeches were delivered by him and Mr. Canning, Conservator of Forests, Western Circle, United Provinces.

The Officer in charge also gave a short speech in which he thanked the Conservator of Forests, Western Circle, for taking a keen interest in the School affairs.

One of the students, on behalf of the class, thanked the Government and the Officers who had deputed them to the School for bettering their future prospects. The whole party was then photographed and the function came to a close.

MD. HALIM-UD-DIN,
Extra-Assistant Conservator,
I/C U.P. Forest Training Class.

NAINI TAL:
10*th July* 1919.

Photo.-Mechl. Dept., Thomason College Roorkee.

Yemané plantation of 1916.
The tree in foreground measures 1'-8" in girth and 36'-6" in height.

VOLUME XLV NUMBER 10

INDIAN FORESTER

OCTOBER 1919.

YEMANÉ (*GMELINA ARBOREA*) IN UPPER BURMA.

A full description of this species and its timber has been given in Mr. A. Rodger's "Note on Gumhar" published in 1913 as *Forest Bulletin* No. 16.

During the past few years experiments have been made in the regeneration of *Gmelina* in Katha Division, and its introduction is now being attempted on a fairly large scale in the Northern Circle

The following are notes on the results of some of these experiments and on the methods now being tried, in the light of the experience gained in Katha.

First a few facts may be mentioned regarding the growth of *Yemané* in natural forest in this region It is widely but sparingly distributed over the plains and lower hills in the northern wet zone, extending to above 3,000 feet wherever conditions are favourable. Its soil and drainage requirements resemble those of teak, but it probably needs more moisture and has less objection to soils with a tendency to waterlogging: it is not found on dry

sandy soil, and attains its finest growth on rich alluvium with good drainage, where it may reach a girth of 8 to 10 feet and a height of 100 feet: unsound stems are rare, except when trees are clearly overmature.

It is seldom a shapely tree, often branching low down and with a bole anything but vertical: logs are not often obtainable over 20 feet long and these are frequently curved. This difficulty of obtaining good logs has certainly contributed to the comparative obscurity of so fine a timber.

The branchy habit is due to the fact that normal branching takes place from all leaf axils concurrently with the year's shoot, so that when the leader is damaged, shoots on one or more already developed branches take up the growth and result in forks standing out at 60° or so from the main stem: this is a common character of the decussate habit, but is in contrast with teak, in which a new leader is formed from a main leaf axil and grows nearly vertically. This feature of *Yemanè* has to be taken into consideration in pruning operations, and is referred to later.

The distribution of mature trees is never gregarious: in some forests one can say with truth that wherever one stands at least one *Yemanè* tree is in sight, but it is often still more scattered. The fruit is produced annually in fair quantity and, like that of Spondias, is usually distributed far and wide by game, so that seedlings seldom survive in any quantity near the mother trees. These which do germinate are, again, so liable to the depredations of game that they are seldom in evidence, and it is even possible that their extreme scarcity in reserves is due to the protection the Forest Department affords to sambur and barking-deer.

Climate.—In Katha Division the rainfall varies between 50" and 80" of which about 90% falls in the 6 months, May to October, showers occurring almost invariably in November and April and occasionally in the remaining months. Dry warm winds occur in March and April, but alternate with moister spells and very occasionally raise the shade maximum above 95°; 80° is rarely touched between early November and late February; but the minimum seldom falls below 40°. Dews are heavy throughout

the cold season and persist even in April in clear weather, such a climate favours luxuriant vegetation and a long growing season, and while showing its effect in the remarkably fast growth of tree species, produces a growth of weeds and grass scarcely imaginable by Forest Officers in drier regions. The altitude at which regenerat'on work has been done varies from 500 to 1,500 feet above M. S. L.

Methods of Regeneration. -Three methods have been tried—transplanting from nurseries, dibbling, and broadcast sowing, and each of these methods is represented in the instances selected as types in these notes

But before describing the results, the following remarks may be made on seed collection and treatment.

The tree in this region flowers in February and March, and fruit begins to fall about the third week in April, being large and conspicuous it is very easy to collect without special measures. Spreading trees with plenty of fruit are selected and visited every two or three days, most of the fruit that falls being thus saved from game. Fruits are put out in the sun as they are collected, and the fleshy integument rots in a few days, separation being assisted by beating with heavy bamboos.

Cleaned seed can thus be obtained in fair quantity by the middle of May, by which time sowing should be done at the latest. Seed collection is done by villagers who are paid Rs 2-8 to Rs. 4 for each basket of seed ready cleaned—one basket weighs 45 lbs. and contains about 48,000 seeds. No particular care was taken in the preparation of nursery beds beyond raising them slightly to ensure good drainage. Seeds were not put in thickly, but were pressed in with the finger about 4 inches apart. If seedlings are required for cold weather planting (described below) nurseries should be sown in September: if for the following season, sowings can be done even later. Seedlings were planted out when from 9" to 1' high; those that were sown too early were found to have grown much too big. Transplanting was not done with any special care as the seedlings recovered quickly and stood being moved even in dry weather.

History and Results of Regeneration Work.—*Yemané* was first tried in Katha in mixture with teak in concentrated regeneration, the object being to retain fairly equal stocking of each species through the rotation. Teak and *Yemané* were planted in alternate lines 9' feet apart on clear felled and burnt areas, and weeded and tended to effect equal survival of both species.

In every case before the end of the first rains *Yemané* had asserted itself as the dominant species, and during the second rains had to be cut back to enable the teak to push up through the rapidly closing net work of side branches. After this it was decided to abandon the teak rows and leave the *Yemané* to itself, and the experiment was given up.

About this time (1916) the idea of equal mixture of teak with other species began to give way to the doctrine of pure blocks, and *Yemané* was one of the trees selected to be grown in "chunks" to mitigate vast expanses of teak. It was also expected that this species would be cheap to grow owing to its ability to form canopy rapidly and save expense in weeding, though its probable value financially as a principal crop was only vaguely foreseen.

In 1916 plantations were made in several places: the most successful one is now described. In February 1916 a flat area was cleared under girdled teak seed-bearers, and a corner of this set aside for *Yemané* owing to its strong grass growth. After burning in April, *Yemané* plants sown a month earlier in a nursery were put out 6' × 6' about the end of May. These were kept weeded during the rains of 1916, and by November are said to have averaged 4' to 5' high over the greater part of the area—only about 1½ acre in all. In the adjacent plot, similarly cleared and burnt, teak plants had been put in and weeded in the same way but showed much less height growth: they had also given trouble by dying off and having to be replaced by new plants.

In the subsequent rains (1917) the *Yemané* began to show its value. An early weeding was done concurrently with the teak, but by July the crowns were beginning to close and suppress the grass and no more weeding was necessary. By the cold weather of 1917-18 an average height of 22 feet had been attained and the

undergrowth consisted of nothing but suppressed Pollinia grass, and shade bearing annuals up to 4 feet high. In February 1918 the plantation was visited by the Inspector-General of Forests who considered the crowns too congested and recommended a heavy thinning at once. This thinning was done in April 1918, but before this a sample plot of 2 square chains was marked out and 229 trees counted, the completeness of stocking being remarkable.

Eighty-eight trees were removed in the thinning ($38\frac{1}{2}$ per cent.) which was made in the canopy only, suppressed trees being left standing. The 141 trees remaining were found to have an average girth of just over 8 inches at $4\frac{1}{2}$ feet and 5 of them had attained 1, foot the largest a girth of 1′ $2\frac{1}{2}$″ and a height of 25 feet. After the rains of 1918 it was decided to remove the suppressed stems left in the sample plot, and 43 more trees were cut out. The 98 stems thus remaining were found in January 1919 to have an average girth of 11″ (the elimination of suppressed stems does not vitiate this figure appreciably), and 34 of them were 1 foot in girth and over. At the same time 11 stems at good distances were selected in this plot and marked as permanent sample trees. The girth of these 11 trees when measurements were taken a year ago was traceable from records, and was found to have increased from 11·2″ to 14·7″. The largest tree had increased from 15″ and 27′ to 20″ and 36′ 6″ in girth and height *respectively*.

In this plantation the great majority of the trees are straight grown, and closeness of spacing has kept branching within bounds.

The usual wealth of branches was produced, but all those on which the leaves were prevented from obtaining light died off at once, and could be knocked off with a stick like those of pine. This is an important point, and makes it uncertain whether a 6′ × 6′ plantation might not with advantage be left unthinned for a year or two longer, so as to obtain a clean bole of 45 or 50 feet. But from the present instance it seems that the strength of the thinning was not excessive, as the crowns in the thinned portion are still fairly small and show no signs of spreading at the expense of the leading shoot. In this case the cost of establishment and

tending of the *Yemané* was not kept separate from the teak, but is estimated at Rs. 8 per acre for the three years : that of teak and *Yemané* together was Rs. 19 per acre but whereas the teak was weeded for three rainy seasons, the *Yemané* needed no tending after it had been through a month of the second rains.

The two photographs of this 1916 plantation here reproduced show clearly the distinction between the portion thinned and that left unthinned.

Other examples of the establishment of *Yemané* by nursery transplants can be given.

In 1918 an area under very heavy elephant grass on which teak regeneration had failed seven years previously was cleared and burnt for stocking with *Yemané*. A number of nursery plants remained over from 1917, but excessively close sowing had kept back their height growth to about 1′ 6″ and caused a number to be weak and suppressed. These plants were used, and it was hoped that by early planting up with such seedlings the grass could the better be kept under. This proved to be the case, and by the end of the season some had reached a height of 8 feet. But this experiment was not altogether successful : the burning in March was too early, and transplanting, which might have been done in April, was postponed to the end of May in order to allow some refuse teak to be extracted from the area. The result was that grass was already well re-established when planting was done at 6′ × 6′, and weeding was necessary from the very beginning. If the grass had been cut and burned later and planting done at once, results must have been more favourable, and if such a grass area is to be stocked with transplants there is no doubt that, in a locality where burning cannot usually be done after April, yearling plants can be put out sooner and must give the best results.

In the same year (1918) *Yemané* was tried with a *taungya* crop of paddy, nursery plants being put out at 6′ × 6′ at the end of May concurrently with the rice sowing. Success was complete, plants attaining 6 to 8 feet in places. But if this method is adopted late planting is an advantage, as forward plants are apt to grow branchy and interfere with the paddy crop.

The mention of late planting leads to another experiment of which the result is not yet certain. Owing to success obtained in moving some plants to fill gaps in the middle of a dry November (these were found to recover at once from the check of transplanting) the idea was conceived of the possibility of winter planting. Heavy elephant grass was at once cleared on an acre plot and burnt at the end of November. Nursery seedlings from 6" to 1' high were put out, and, to make matters safe, the planting holes were filled with water and earth filled in round the roots before the water subsided. A hundred seedlings were, however, planted out without water as a test. This plot was watched throughout the dry season. Most of the seedlings recovered at once and did not drop their leaves till March, when new growth began : in some the leader died and fresh shoots appeared from near ground level. No watering was done, and no rain fell till April, March being exceptionally dry and hot for the locality. In April a few plants were found to have died as a result of the excessive drought in March, but those planted without water suffered no worse than the others.

Countings will be made to ascertain the rate of survival, and possibly 10 per cent. may be found to have succumbed, but the experiment may be said to have been successful as far as it has gone, and in future such work will be begun earlier—end of October or early November—and only the strongest nursery seedlings used.

The object of this method is the establishment of a crop of *Yemané* seedlings in areas liable to be covered with a heavy growth of grass, at a season when grass growth is in abeyance and no weeding is needed, so that when grass growth is resumed the *Yemané* will have already started its new growth, and will be pushing ahead at its strongest at a season when it would under normal circumstances be suffering the check of transplanting. It is hoped that thereby weeding expenses will be much reduced and that none will be necessary in the latter half of the coming rains. Possibly even broadcast sowing in the early cold weather may prove successful. Nursery beds sown in a level moist spot near a

stream, in December 1918, were at once well stocked with seedlings, which survived and began fresh growth in March without watering. If sown in October seed would have germinated even in drier places, and in a season of normal winter rainfall would probably have survived. The experiment of broadcasting at this season, however, remains to be made, and even if successful can hardly show great advantage over the summer sowings to be described.

The luxuriance of grass and weed growth in such a locality as Katha points every time to the necessity for anticipating it by early establishment of the crop of *Yemané*. This leads to the question whether seed can be sown at periods up to a year after its collection. This is under investigation, and was first suggested by the appearance of natural seedlings in clearings under seed-bearers well in advance of the ripening of the year's fruit. Hitherto all that has been ascertained is that most of the seed of 1918 is certainly still fertile, and some of it sown in nurseries early in April has already germinated. Comparative tests will be made, and if successful, no doubt the policy of using none but year-old teak seed will be adopted in the case of *Yemané* also, for spring sowings. The importance of early germination is accentuated in a climate where vegetation begins early, and the ripening of tree seeds is if anything later than in drier localities.

Dibbling.—This method has not been tried on a large scale in Katha, but two instances are worth describing.

A large plot of ordinary mixed forest, fairly flat, was cleared and burnt in April 1918. Owing to early rain the fire was a poor one, except where two or three large clumps of *Wapyu* bamboo (*Dendrocalamus membranaceus*) had been cut and gave a fierce blaze, part of this area was dibbled 6′ × 6′ with *Yemané* seed, four or five to each peg, in the middle of May. Germination started within ten days, and seedlings were weeded ; but where the fire had been weak soft weeds and Pollinia grass proved very troublesome from the beginning and in some cases overwhelmed the young plants. On the other hand, where the bamboo clumps had been burnt, roots and grass rhizomes seem to have been completely

destroyed, and no weeding was found necessary throughout the rains except the removal of small cucurbitaceous ground creepers. Partly for this reason and partly, without doubt, owing to the good manuring effect of the ash *Yemané* plants made remarkable progress, several reaching a height of between 11 and 12 feet by the end of the rains, and forming a complete canopy. Such extraordinary growth had not been attained by transplants—even when plants from the former year's nurseries were used.

The other case was very difficult. An area under a thick growth of *Thetké* (Imperata) grass was cut in February and burnt in March. Seed was dibbled in like manner in May, by which time the new grass was already fairly strong. Only about 50 per cent of the pegs showed plants in the first month, and it was supposed that crickets had devoured the young seedlings before they appeared above ground. Plants that germinated showed very poor growth, few of them reaching 2 feet in height in their first season and all appearing unhealthy. The influence of the grass may be fairly suspected in this case, as it is of course a notorious pest in rubber plantations. The nursery plants put in here to fill blanks showed similar poor growth, though repeated weeding was done, but it is hoped that the grass will eventually be overcome and the *Yemané* will go ahead in the end.

Broadcast sowing.—One experiment in this method was made in 1919 and met with remarkable success. A hillside on which a *taungya* crop of rice had been grown in 1917 was selected, a "*ponzo*" which in another year would have been covered with secondary growth of softwoods of no value. It was hoped that closely sown *Yemané* on cleared ground would, with some assistance, get the better of such growth and establish itself fairly cheaply.

In April 1918 weeds were cut and an attempt made to burn them, but, except where paddy straw was fairly thick, this was not a success, intermittent rain also interfering. Finally, late in May, unburnt débris were removed and the soil lightly raked over, and *Yemané* seed of that year was sown broadcast at the rate of one basket 45 lbs.) to the acre. The weather being rainy, germination started within a week, and the soil was soon covered with *Yemané* seedlings

to the entire exclusion of weed growth. Except in places where straw had been scanty and no fire occurred, absolutely no weeding had to be done throughout the rains, and when the writer saw the place in October the whole hillside was a solid mass of *Yemané*, its stems as dense as corn and the soil under its shade clear of everything but a few procumbent creepers. Growth was not so rapid as in the dibbled plot already mentioned, but in places the canopy was 8 to 9 feet high. In so crowded a crop it was not surprising to find girth sacrificed to height, though there were already indications that certain stems would become dominant without further tending.

A remarkable feature in this case was the refusal of any of the young *Yemané* plants to be suppressed. Hardly a stem did not share in the canopy; even where 3 seedlings grew from one fruit, each of them had its crown of leaves 7 or 8 feet above ground.

The proper treatment of such a crop after its first year is certainly a system of annual thinnings until, say, an average interval of 8—10 feet is reached, *viz.*, for three or four years. But the cheapness of the method will probably lead to its adoption over considerable areas, and such thinnings may prove impracticable. In this area, therefore, the effects of two extreme treatments are to be tried.

A fully stocked plot of 1 square chain was taken in January 1919 and thinned heavily, some 80 per cent. of the stems being cut out. The spacing appears ample, and it is hoped that no further thinning will be needed for two years at any rate. Even after the thinning there are 330 stems left, which suggests that many more might have been cut out but for the inevitable branching that would ensure at the expense of height growth.

It may be mentioned that the heavy pollard-growth that will shoot from the cut stems will be effectual in keeping down weeds in the coming rains, so there is no fear from that quarter.

The other treatment consists merely of leaving the crop at its present density for another season at least, in the hope that the potentially dominant stems will prove well enough distributed and will be able to assert themselves. In a square chain, of which

one corner was almost blank, 1,374 saplings were counted, and full stocking estimated as 16,000 per acre.

The value of broadcasting, if success on this scale is assured, lies in its extreme cheapness of establishment on localities subject to heavy weed growth, where no assistance can be obtained from field crops. Such a method of re-afforestation in "*ponso*" (old taungya) could be adopted without further delay, limited only by the amount of *Yemané* seed that can be collected: and, if it proves practicable to leave such crops to themselves without fear of deterioration, the value of the scheme will be doubled. *Ponzos* of over one year's standing would of course give more trouble owing to the greater strength of the secondary growth, but would probably differ only in needing one or two weedings in the first half of the rains. Attempts are to be made in a second year *ponzo* in Katha this year by way of experiment.

The cost of establishment per acre on the one-year-old *ponzo* described can be analysed thus—

	Rs.	a.	p.
Collection of one basket of seed (cleaned)	2	8	0
Clearing, burning and raking soil ...	0	12	0
Sowing seed	0	4	0
Total ...	3	8	0 per acre.

In this case one basket per acre was used, but it is probable that the use of half a basket would be equally successful if carefully sown.

In teak *taungyas* in Katha a new method is to be adopted this year to take the place of the planting, dibbling, or broadcast sowings hitherto in practice, and *Yemané* will also be sown in the same way as an experiment.

The method is as follows:—Bamboo tubes are provided to each sower, and seeds are sown through the tubes, which are rested on the ash covered soil, and then roughly trodden in by the foot, 3 or 4 seeds are sown at each spot, and can be directed by means of the tubes into suitable places, *e.g.*, stumps, rocks and other unprofitable things will be avoided, and on steep slopes ledges

or hollows can be selected for the reception of seed. Intervals can be regulated as required, but usually will be one pace or approximately 3 feet. No attempt will be made to sow in straight lines, and pegs will only be used to mark the spot where seeds are sown, being put in after sowing by a cooly following the sower, these pegs will show the progress of sowing, and will be small and of a temporary nature, there being no necessity for them to survive for countings after the paddy is reaped.

If *Yemané* seeds are sown 3 at a time at 3 feet intervals, about half a basket will be used on an acre, and with normal germination at least one plant at each peg should be assured even if only 2 seeds are sown. The drawback of broadcasting are avoided, such as difficulty of control and heavy seed expenditure with uncertain distribution, and, by being pressed in, the seed stands less chance of desiccation or non-germination owing to resting free on the surface of the ground.

Dangers to which Yemané is liable.—Hitherto no insect has appeared doing material damage in plantations except the problematical cricket already mentioned, which confined its energies to an area under *thetkè* grass. But one very serious danger has shown itself all too prevalent in Katha, and that is sambur. All the Katha plantations have suffered except those in the vicinity of human dwellings, even saplings 12 feet high being broken down by the animals in search of green shoots and leaves. Severe sambur grazing, which is almost confined to the cold weather, results in the complete smashing of the young tree so that no remedy but coppicing is possible: moderate grazing may only affect some of the shoots, but the leader seldom escapes if less than 8 feet from the ground.

If a rudimentary shoot on the main stem is available pruning can be done and a sapling allowed to grow on, but more often it is preferable to coppice. As far as is known, *Yemané* coppices well if cut back early in the season, but some sapplings cut back by the writer about the middle of June were a complete failure.

An effectual method of keeping sambur away from *Yemané* areas has not yet been found, but many devices remain for trial

and the trouble is certainly not insuperable. It is, however, more serious than might be imagined: a *Yemané* plantation seems to attract all the sambur from a whole country-side, and hitherto the ordinary paddy-field method of clappers worked from a hut has not succeeded. Next season trial is to be made of bamboo rope entanglements, a single-rail fence, painted white, tins streamers and what not, not to mention patrolling with guns, and it is hoped that outright fencing will not prove a necessity. Methods such as scarecrows, clappers, and even beating, are only temporary in effect, and useless when the beasts really mean business. Bison have also been detected as destructive, but need not usually be feared.

Curiously enough, cattle seem to be averse to *Yemané*. In two cases in Katha bullocks and cows are regularly grazed among young *Yemané* and refuse to touch it: in fact their presence is looked on as beneficial in keeping down weeds and grass. Even in the dry season, when sambur grazing is at its worst cattle in these forest regions can find plenty to eat, and seem to dislike *Yemané* as much as they do teak. Ponies also refuse it, so there must be something distasteful in it.

This may seem remarkable to those whose experience of grazing is confined to the drier parts of India, but in Upper Burma, except in the dry zone, there is seldom any lack of green fodder, and its superabundance in young regeneration areas is leading to the encouragement of grazing, especially in teak regeneration, to save expense in weeding.

The only other serious "danger" hitherto noticed in the Katha *Yemané* areas was the hailstorm of 5th April 1919, which almost completely stripped one of the best of the plantations of last year of its new shoots, the leaders being already a foot long on some of the trees. But most of these trees will recover without coppicing, and several such storms every year would be preferable to the visitations of sambur.

Rate of Growth and Rotation.—The rate of girth increment for the first three years in the planted area described first promises well for short rotation working of a very valuable timber

tree. The writer, after seeing the third year's growth, made a rough estimate of the probable future increment, allowing for considerable slowing down and arrived at a rotation of 30 years for a mean girth of 6 feet and about 100 trees on the acre. In order to get something substantial to go on seven good average free-growing *Yemané* trees were felled in natural forest, and information obtained from them as to rate of growth.

These showed an average girth at breast height of 4′ ½″ and an average age of 21 years, but owing to difficulties in early youth averaged only 9″ (with bark) at three years. The mean girth of the 11 sample trees in the 3-year-old plantation mentioned above is 14·7″ after three years, and if a future increment parallel to that of the natural trees, *viz.*, 3′ 3½″ from the 4th to the 21st year is assumed to take place in the mean sample tree, it would attain 4′ 6″ in 21 years. Continued growth with the same mean annual increment of 2·2″ would bring it to 6′ girth at an age of 29 years.

Such calculations are of course based on slender data, but there is no reason to suppose that the natural trees taken were not typical: they varied considerably, the fastest grown being 4′ 6″ in girth in 20 years and the slowest 2′ 11″ in 19 years, and it is probable the growth of plantation trees will approximate to the faster rate and even exceed it. It is, therefore, reasonable to suppose that a mean breast girth of 6 feet in 30 years will be attained in suitable localities.

Whether fast growth is a good quality in *Yemané* timber is not known, but there is nothing in its structure to lead one to suppose it is not. European oak and ash are the more valuable if fast grown, and wide-ringed teak stands weathering much better than that with congested rings. Nor can we yet say on what rotation it will pay best to work *Yemané*. If the manufacture of matches is to be considered, a girth of 4′ 6″, reached say in 17 years, would probably be at the top of the financial rotation curve. If planking for furniture and building purposes is the main demand, 6′ girth with bark should be quite enough It is fairly certain that the enormous squares required in the case of teak will not be needed.

Photo.-Mechl. Dept., Thomason College, Roorkee

Yemané plantation of 1916 at Kokaung, Katha Division. Thinned portion on right.

Further, it may be found that short-length timber produced by very heavy thinnings every four or five years, and consequently enhanced girth increment, and shortened rotation, may pay best.

But whatever may be the decision on points of management there can be no doubt that this tree if grown under such conditions must form an exceedingly profitable crop, well worth growing on a considerable scale, provided that localities well suited for export are selected, and floating will always be the cheapest extraction method of light timbers, whatever the future may bring forth either on land or in the air.

KATHA. C. G. E DAWKINS, I.F.S.

ARTIFICIAL REGENERATION IN SAL FORESTS.

Now that uniform systems of management are being more and more employed in Sal forests of the United Provinces, artificial regeneration has become a question of great importance. Not very long ago an article appeared in the *Indian Forester* describing the system of planting in vogue in the Gorakhpur division, so it is not proposed to describe this again in any detail, but merely briefly to state the main points. Plants are raised in a nursery and when they are about two or three years old,—the stage of development reached rather than the age being of paramount importance,—they are planted out in holes dug in the forest. Before planting the roots are pruned to a depth of 1 ft. 6 inches and the stem to only a few inches above the ground. One point which also needs repetition is the proved necessity for constant attention, weeding and working the soil, during the rains for at least the first three years after planting. Plants put out in this way in the early rains of 1916 are all doing well and look quite healthy, but their development is not yet very satisfactory, the average height now being only about 1½ feet and the best developed about 2 feet. The average height of coppice shoots, on the other hand, it very roughly about 15 feet in four years. From this it is quite clear that the planted sal cannot compete with coppice shoots, at least certainly not for many years, although subsequently the reverse

may be expected and the plants will probably develop into finer trees than those obtained from coppice. It is now a known fact that until the root system is properly developed the young plant either dies back every year or remains merely alive but does not appreciably develop in height.

The areas under the uniform system in Gorakhpur are worked on a 40 years rotation and $\frac{1}{40}$th of the area is clear felled every year. After the felling a sea of grass and weeds comes up, mixed with the sal and coppice shoots of other species. Where the crop is good the coppice shoots quickly come through and the grass dies away, but this is not the case in the blanks and poorly stocked places. *Accordingly, where planting and sowing have to* be done to fill up the area, a very heavy grass growth has to be contended with and the expense of keeping the young plants clear is very considerable. Also the smaller natural seedlings on the ground get either smothered by the grass or suppressed by the quick growing coppice. The necessity for having a good percentage of natural grown or planted trees on the area, and not having the whole stock composed of coppice shoots need not be harped on.

To sum up, the disadvantages of sowing and planting after the fellings are, owing to the slow development of artificial regeneration, as compared with coppice shoots :—

(1) The difficulty and expense of tending owing to the resultant heavy growth of grass.

(2) The suppression in the smaller blanks, by the quick growing coppice shoots.

(3) The resultant crop is not of even growth.

It is obvious that in most cases some form of artificial regeneration will have to be resorted to in order to make the new crop a full one. Accordingly the following procedure may, I think, be given a trial, or something at any rate on these lines.

Ten years before the area is to be clear felled it should be gone over carefully and wherever the cover is too dense or wherever there are natural seedlings on the ground the overhead cover should be opened out. These fellings should be in the nature of

light preparatory fellings. During the next four years cleanings of inferior species should be made every year and every effort made to establish existing young natural regeneration and encourage fresh regeneration.

In the fifth year before the felling, blanks and places, in which it is not expected that a full crop will be obtained from coppice, should be planted or sown up. Such artificial regeneration would then receive annual tending as may be necessary until the time for clear felling arrived. In this way it is hoped that the root system would be properly developed and that when the area came to be felled over these plants would grow up more or less evenly with the coppice shoots. Also by planting and sowing in this way before the felling much expense would be saved, for the growth of grass and weeds inside the forest, even in blanks, before the felling, is far less than that in the clear felled areas.

To sum up again, the advantages of sowing and planting before the fellings are :—

(1) The root systems of the artificial regeneration would have some time to develop and the plants may be expected to be able to compete in growth with the coppice.

(2) Owing to the growth of grass and weeds being very much less inside the forest, the difficulty and expense of cleaning and tending would be much less.

(3) The new crop would be more even grown.

It is not yet known how long it will take before the plants will begin to develop appreciably in height growth and five years may be too short a period, but it is certainly worth trying experimentally.

W. A. BAILEY,
I. F.S.

GORAKHPUR.

OFFICE REFORM.

Mr. Oliphant, in an article on office reform in the *Indian Forester* of April 1919, stated that a carefully worked out scheme of classification of correspondence introduced into his circle in place of an antiquated system of filing reduced his clerical establishment to a state of gibbering dementia. I have endured a similar ordeal, having been in one circle for a period of three years during which four systems were in force. The first system may have been an extremely bad one and it is probable—although I cannot give an unbiassed opinion—that each of the following systems was a decided improvement on the one which it replaced, but instead of facilitating easy reference, the result of these reforms was to create more and more confusion, until finally it was almost impossible to find the simplest reference. This experience convinced me that the weakness of our classification of correspondence is its liability to change. As a rule the standard of classification of revenue and expenditure in most offices is very fair, whereas that of correspondence is decidedly low, and even in some cases deplorably bad, and I think this difference in efficiency may be attributed partly to the fact that the system is in the former case a permanent one and partly that the same system is in force throughout the province. In many ways it is an archaic system. For instance, it is impossible to classify separately our two main sources of revenue, namely, that received from lessees and that derived from the issue of licenses, but I doubt whether even the keenest advocate of devolution of powers would wish to make it possible for the sub-heads to be continually changed.

It is of great advantage to have one uniform system throughout the province so that when one is transferred to another division or circle one is not obliged to learn a new system, and while regarding reform with a certain amount of suspicion, I should not be unwilling to have the system of classification of correspondence overhauled by a small committee of D. F. O.'s with a Conservator as chairman, for the purpose of prescribing a uniform system throughout the province, provided it were guaranteed that

any system adopted would be permanent and safe from further change. The system I should prefer is one modelled on the system of classification of revenue and expenditure. I would divide all correspondence into files (corresponding with budget heads) which could be denoted by a letter suggestive of the group of subjects dealt with. Thus A for Accounts, B for Buildings, C for Communications, etc. I would then divide each file into a reasonable number of permanent cases (corresponding with budget sub-heads) to each of which would be given a serial number; and to avoid complication, a point the importance of which is not sufficiently realized by reformers, I would not allow the classification to be taken any further. A case is usually taken to mean a collection of papers to which the correspondence clerk allots a separate case cover, but under the proposed system a case would consist of the papers relating to a definite subject. In order to obtain a uniform system throughout the provinces, it would be necessary to adopt what may be considered somewhat vague and general cases. Thus whereas it is the present practice to open a case for every new rest-house built or proposal for reservation, it would be necessary to adopt general cases, such as 'Construction of new Rest-houses' or 'Proposals for Reservation.' Many people have a love of detail, and if it were permissible further to divide the budget sub-heads, it is probable that, for instance, the revenue from bamboos would be classified in further detail to show the reserve or range from which it was derived. The fact that further classification is not permitted does not, I think, cause serious inconvenience. It is, however, not only permissible, but the usual practice, to adopt a certain amount of method in the arrangement of items under a given sub-head. Thus the items under A-IIa are always arranged in the following order, teak timber, reserved timber, and unreserved timbers. In the case of correspondence, without allowing the classification to be taken beyond the case, I would not only authorise, but definitely prescribe that the papers in any case should be arranged into convenient bundles, each of which would be given a different cover. Thus in the case 'Construction of new Rest-houses,' I would open a new bundle for each new rest-house, so that in this case there

would be as many bundles as there were rest-houses in the division. Similary in the case 'Personal records of subordinates of the Executive Establishment' there would be as many bundles in this case as there were subordinates. In the case 'Repairs to Forest Rest-houses,' I would, as soon as the annual report had been written up, send the whole bundle of papers in this case to the record room and open a new bundle so that in this case there would be a bundle for every year.

Under this system it would, I think, be much easier to trace any reference than at present. Instead of starting a new register of cases every year which means that the case numbers are changed every year, there would be a printed index of files and cases from which one could find out where the papers on any given subject would be stored in the record room. The almirah behind the table of the correspondence clerk and the shelves of the record room would be divided into as many partitions as there were files prescribed. The partition would contain a number of cases arranged according to their serial numbers. Any given case might comprise a number of bundles, but all the bundles of, say, case B.10 would be found sandwidged in between case B.9 and case B.11. The bundles would be arranged in chronological order so that even a clerk with no special experience should be able to consult the index and find any paper required.

A further advantage of this system would be that the Conservator's office would be able to exercise a general supervision over the classification of correspondence by clerks in divisional offices. Thus if a divisional clerk registered a letter as 2159/P-13 when the correct file letter and case number should have been /R-29 the Conservator's correspondence clerk, when despatching the reply, could underline the file letter and case number with red ink to indicate that a mistake had been made. In the case of letters on original subjects received from the Conservator the clerk would simply adopt the classification given.

"PEDESTRIAN."

1st June 1919.

TREATMENT OF TEAK FORESTS IN THE C. P.

The teak forests of the Central Provinces were reserved during the period 1860—1880. Treated at first unscientifically, methods have gradually been systematized until now most of the forests are worked under regular systematic Working Plans. Briefly these Working Plans prescribe coppice with standards or improvement fellings according as it was considered that the forests would eventually be worked as coppice or high forest. It is with the latter that this note deals.

The teak forests of better quality which it is desired to work as high forest consist of a mixture of teak with other species of less value. The quantity of teak varies from almost pure teak to a forest of mixed species with only occasional teak trees. The stock is very dense in places, very open in others and there are numerous blanks. The age classes are mixed up, and mature, middle aged and young trees are frequently found together. The treatment by improvement fellings aims at the eventual management of these forests as selection forest and are admirably suited to this purpose. The Working Plans divide the areas up into 20 or 30 coupes in each felling series and prescribe the working of one coupe annually. All dead, dying, malformed and otherwise unsuitable teak trees are to be removed and to be replaced by coppice or seedling growth. The work is usually done well. After the improvement fellings, which include departmental cutting back operations, coupes receive no attention whatever except that in a very few Working Plans climber cutting is prescribed every five or ten years. A forester's most important work—regeneration—is practically ignored in the Working Plans. While on tour Divisional Forest Officers usually have a look to see how it is getting on but nothing is done to help it, except that occasionally established regeneration is helped in the departmental cutting back operations by removing overhead cover.

The selection system of management is now generally admitted to be obsolete. If we accept this, and agree that the ultimate treatment will be one of the regular systems with

concentrated regeneration and concentrated fellings then our system of improvement fellings is also obsolete. The Working Plans Officer of the future will be faced with the problem of converting a forest which has been managed for 40—60 years with the object of getting the age classes distributed throughout the area, into a forest in which the age-classes are in even aged blocks. The following descriptions of a well-known forest in Berar at different periods of its existence and a forecast of the condition of the crop at the end of the present series of improvement fellings illustrate well the problem this officer will have to face.

The following description was written in the Working Plan of 1895 which regulated the working of the forests from 1895 to 1915:—

"The present condition of the crop of the Bairagarh Forest which has enjoyed twenty to twenty five years of protection from fire and grazing may be generalized as follows :—

There is first the old growth of ante-protection days injured by pollarding, lopping, shifting cultivation, forest fires, injuries from cattle, and every conceivable abuse ; most of the constituents of this category are naturally unsound and misshapen. Next, and mixed with the above, we have a sprinkling of poles whose age is somewhat longer than the period of protection, and the result of seedling or young coppice shoots, which formed an irregular and scanty advance growth when protection began. Lastly, the present *seedling and advance growth produced from the seed* of the more vigorous of the old ante protection stock, and which has been coming up gradually faster and faster since the surface of the soil has been brought by protection into fit conditions for the support of tree plant life."

The following description is taken from the present sanctioned Working Plan written in 1915 :—

"The old growth of ante-protection days has been largely replaced by coppice shoots, the results of improvement fellings, especially in the later coupes where exploitation has been more thorough. The sprinkling of teak poles mentioned as constituting an advance growth when protection began has now

reached middle age or is approaching maturity and will give the first yield when final fellings are introduced. The younger growth of teak now consists of coppice, and seedlings of all ages, the latter predominating."

From the above two descriptions the condition of the crop in coupes number 1 worked in 1895-96 and again in 1915-16 under Improvement Fellings as it will be in 1935 when the plan comes up for revision can be fairly forecasted as follows:—

All the misshapen and unsound old trees will have been removed. There will be a very few old well-shaped trees which were of timber size in 1864 when the forest was reserved. Their age will be say 90 years upwards. There will be a number of trees which were young saplings and seedlings when the forests were reserved. Their age will be 70 to 90 years. There will be the crop which sprang up immediately on the introduction of reservation and protection. Age 60 -70 years. The Improvement Fellings of 1895-96 will have produced coppice aged 40 years and the Improvement Fellings of 1915-16 will have produced coppice aged 20 years. All these age classes will be thoroughly mixed in the coupe, conditions ideal for the introduction of selection fellings, but presenting serious difficulties to the Working Plans Officer who is called upon to find a system by which concentration of age classes and concentrated regeneration may be obtained.

The problem that would face the Working Plan Officer now is, of course, no less difficult. The suggestion is, why not introduce concentrated regeneration as soon as possible. The only answer can be because we do not know how to do it. We should, therefore, start experiments on a large scale in every division in which the teak is considered good enough for high forest. The note, dated 23rd March 1918, of the Inspector-General's tour in Burma, shows us that one province has tackled the problem successfully. Our experiments might start on the lines there indicated. The rotation at first will have to be fixed more or less arbitrarily, but we have some data to go on. The Hon'ble Mr. J. W. Best in his article in the *Indian Forester* for September 1918 comes to the conclusion that 60 years is a suitable rotation for teak forests in two ranges of

Hoshangabad Division and the experience of most forest officers in the Central Provinces will probably lead them to agree with him.

It is not suggested that the whole of our better quality teak forests should be lumped into a high forest working circle There are many areas where the conditions are peculiar and the selection system may have to be retained. Examples are steep slopes where heavy felling would be likely to expose the soil to erosion ; frost hollows ; areas, where bamboos predominate and which can more profitably be worked as bamboo forest with a teak overwood.

Assuming that our policy is to introduce a regular system and we accept some such rotation as 60 years, a method would have to be devised to convert the forest into a more or less regular series of age classes. The case of Bairagarh Reserve mentioned above is in many ways not typical, but was cited as an example showing what our present system would lead to. I believe I am right in saying that no other teak forest has been completely worked over by improvement fellings and in no other forest will the age classes be found to be so mixed as they are in Bairagarh. The Working Plan Officer would have to stock-map his forest first and exclude areas which are of poor quality to be worked as coppice and other areas for special reasons. The area to be worked as high forest would be split into periodic blocks. Three would be ample at first with a sixty years' rotation. The working plan would prescribe regeneration of one block and into this the Working Plan Officer would be expected to place the compartments containing the greater number of mature trees. He might also include areas containing large quantities of established regeneration and by removing the overwood and replacing it by coppice, call the area regenerated. The effect of this would be to reduce the time required to regenerate the first periodic block. To the second and third periodic blocks would be allotted areas containing the greater number of older and younger immature trees and they would be treated during the first period to a series of fellings, the object of which would be to favour the growth of that part of the growing stock which is most nearly the age that the periodic

block in question is supposed to represent. Thus if block I is under regeneration, block II would contain those areas in which trees from 10 to 30 years old predominate and the fellings in this block would tend to favour trees of this age. Similarly the fellings in block III would tend to favour trees of 30–50 years of age.

It is unnecessary in this short note to discuss the advantages of concentrated regeneration methods over the selection system of management. The question has been thrashed out in Burma and the decision seems to be all in favour of the more regular method. The whole object of this note is to emphasize the fact that if we *are going to scrap the selection system we should also scrap* improvement fellings, and introduce regular methods at once.

Teak is by far the most important timber tree in the Central Provinces and yet our knowledge of its sylviculture is almost *nil*. The better class teak forests of the province could be divided into classes by soil, growing stock, locality, etc., and in each class, in each division, experiments on a large scale should be commenced to determine how it can best be regenerated. In Burma they seem to be regenerating teak as pure forest. Many forest officers of this province hold the opinion that it should be grown mixed with other species. We have to determine the proportion of teak and modify our methods to obtain it. The species to be encouraged in these mixed teak forests have to be selected and the value of fire as a help to regeneration must be investigated. The real value of fire-protection has also to be determined. There is considerable doubt as to its necessity in established forests past the regeneration stage. The Central Provinces spends over a lakh annually on fire-protection and under half a lakh on works of improvement (A. VIII. g). At first we shall probably have to accept coppice shoots as regeneration but as our knowledge of the sylviculture of teak increases we may be able to dispense with it. *As yet we do not know definitely that seedling teak produces* a better tree than a coppice shoot.

The object of this note is, in short, to urge that the method of managing our teak should be discussed and decided. If the decision is in favour of concentrated regeneration, then let us start

as soon as possible. If the decision is for the selection system let us at any rate do it scientifically and determine our rotation and the possibility of our forests. The continuance of improvement fellings as they are now carried out is little more than a confession of ignorance.

C. M. HARLOW, I.F.S.

30th May 1910.

LIST NO. I.

PLANTS USED AS INGREDIENTS IN THE MANUFACTURE OF COUNTRY SPIRITS IN SONTHAL PARGANAS.

No.	Local name (Sonthali).	Scientific name.	REMARKS
1	Chaulia	*Ruellia suffruticosa*	An essential ingredient.
2	Damka-dura	Not identified	Ditto
3	Ralli	*Piper longum*	...
4	Manjur Chuli	*Elephantopus scaber*	Used in Sambalpur also.
5	Saram-lutur	*Clerodendron seratum*	..
6	Tejo-mala	*Cissampelos Pareira*	...
7	Likathi	*Polygala crotalarioides*	..
8	Hat	*Holarrhena antidysenterica*	Used in Sambalpur also.
9	Goti	*Croton oblongifolius*	...
10	Hutar	*Indigofera arborea (pulchella)*	...
11	Kawet	*Abrus precatorius*	...
12	Kia-baha	*Pandanus fascicularis*	Used also in Sambalpur.
13	Atkuti	*Echinops echinatus*	...
14	Kalmeg	*Andrographis paniculata*	..
15	Kargali	*Cleistanthus collinus* or *Lebidieropsis orbicularis*	... Used in Sambalpur also
16	Kedar Nari	*Asparagus racemosus*	Ditto.
17	Dimboo baha	*Ocimum Purpurescens*	...

No.	Local name (Sonthali).	Scientific name.	REMARKS.
18	Badgocha	Probably a species of *Vernonia*	...
19	Atkir	*Smilax macrophylla*	Used in Sambalpur also.
20	Karla da	*Momordica Charantia*	...
21	Kolo	*Dioscorea daemona*	Used in Sambalpur also.
22	Matkom chal	*Bassia latifolia*	Bark only used
23	Sarjom chal	*Shorea robusta*	Bark only used

LIST NO. 2.

Plants used as ingredients in the manufacture of country spirits in Sambalpur, that are found in the Sonthal Parganas but not used here.

No.	Local name (Sonthali).	Scientific name.	REMARKS
1	Per camra	*Helicteres Isora*	...
2	Juar	*Andropogon Sorghum*	...
3	Barangom	*Vernonia cinerea*	..
4	Bhernda	*Jatropha Curcas*	...

NOTE.—The roots of all these plants are used except Nos. 21 and 22 in which case it is the bark.

J. P. HASLETT,
Divisional Forest Officer,
Sonthal Parganas Division.

14*th May* 1919.

NOTE ON "RANOO."

ITS COMPOSITION, PREPARATION AND USE IN THE MANUFACTURE OF COUNTRY SPIRITS.

Ranoo.—Is a preparation made from the roots of two or more of the plants mentioned in the list of the plants used as ingredients in the manufacture of spirits, combined with various spices and the flour of rice, or the marua.

2. *Preparation.*—The roots of the first two plants named in the list are essential for its preparation, *viz.*, "Chaulia" and "Damka-dura," those of any of the others may be added.

The roots are washed and ground in water, together with the following spices and flour:—

(1) Pepper corns.

(2) Cumin seed (Jira).

(3) Cardamoms (Ilachi).

(4) Ajwain (Carum copticum).

(5) Rice flour.

In the proportion of—

10 seers rice flour.

$\frac{1}{4}$ seer roots of "chaulia" plant.

$\frac{1}{4}$ " " " "Damka-dura."

1 tola each of the roots of any of the other plants except of "Kolo" and "Kargali" which are poisonous, the smallest bit therefore being used of the two latter.

3. This mixture having been prepared, it is made into little round hard pellets the size of a marble.

4. *Uses.*—These round pellets go by the name of "Ranoo," and are used to bring about fermentation in the manufacture of rice beer.

5. Country spirits are made in the usual way by the process of boiling rice or other grains, two of these pellets of "Ranoo" being added for every $1\frac{1}{2}$ seer of rice, and the mixture allowed to stand in a jar from four to six days to allow it to ferment, when it is fit to drink.

J. P. HASLETT,
Divisional Forest Officer,
Sonthal Parganas Division.

14th May 1919.

EXTRACTS.

[We reproduce below an article from the Canadian Forestry Journal for May 1919 in which the use of aeroplanes for assisting in the detection of forest fires is described as an established fact.

The use of aircraft has already been suggested in the pages of the *Indian Forester* for the purpose of stock mapping and our suggestion that it might be possible to obtain the use of military craft in peace time appears to have already been initiated in the United States for fire detection. It appears to us that observation balloons or the small type of airship used for patrolling the coasts would be more suitable for the purpose of stock mapping than aeroplanes.—HON. ED.]

CANADA STARTS AERIAL FOREST PATROL.

FIRST EXPERIMENTS WILL BE CONDUCTED IN CENTRAL QUEBEC WITH HYDRO-AEROPLANES.

There is every possibility that Canada will enjoy the distinction of being the first nation to institute an aerial forest patrol. By permission of Hon. C. C. Ballantyne, Minister of Marine and Fisheries and Naval Affairs, two hydro-aeroplanes have been released to the St. Maurice Forest Protective Association for use in Central Quebec. At the date of going to press the Association's pilots were at Halifax preparing to bring the machines to Three Rivers.

The release of the hydro-aeroplanes for forest patrol experiments was obtained only after great difficulty. The original application of the St. Maurice Association, supported by the Quebec Government, was favourably received by Hon. A. K. Maclean, acting in Mr. Ballantyne's absence, and later nullified by Mr. Ballantyne, the latter's decision being again modified after

a meeting of a deputation of the Canadian Forestry Association and the Aerial League of Canada. The part played by the St. Maurice Forest Protective Association in negotiations is worthy of high praise inasmuch as this body volunteered to pay practically the entire expense of maintenance of machines, salaries of pilots and other items of heavy expense so as to secure, not only for the St. Maurice region, but for all the Government Departments and other private associations in the Dominion, the data absolutely necessary before any system of air patrol can be entered upon. Most observers of the negotiations will doubtless conclude that the Dominion Government has made a remarkably good bargain for the reason that several of the Dominion Government Departments have already applied for the use of hydro-aeroplanes for forest patrol and will now be able to avail themselves of the experimental results in the St. Maurice territory. The first pilot to inaugurate the patrols will be Mr. Stuart Graham, who participated as an airman in the British Government's fight against German submarines. Mr. Graham will have the fullest co-operation of the officials of the Royal Canadian Naval Air Service. Experimental work will be conducted in the use of wireless telephones and telegraphs. It is intended also to try out the use of aerial cameras in mapping forests. The possibilities of this work are most promising.

The flying boat type has been regarded as being most applicable to the conditions accompanying forest patrol in the province of Quebec where lakes and rivers are almost always within reach as convenient landing stations or in case of accidents. From the point of view of the Canadian Forestry Association, the confidence expressed by returned aviators in the efficacy of aerial patrol of forest areas and the ease of forest mapping called for immediate experimental trials. No one having to do with the securing of the Dominion-owned machines for use in Central Quebec has the temerity to advocate aerial patrol as a cure-all for forest fires nor anything but a probably useful auxliary to present means of fire detection. Recently the Government of Ontario requested from the officials of Argyll House, London,

an estimate of the cost of a system of aeroplanes for use in the forested districts of Northern Ontario. Instead of mapping out a modest experimental plan, the officials of Argyll House concocted an elaborate and highly expensive scheme whereby the Government of Ontario might easily be called upon to pay out close to one million dollars during the first year. Quite properly the Ontario Department of Lands and Forests rejected the scheme implying thereby no adverse opinion of possible advantages of aerial patrol for Ontario. The Quebec experiments will probably determine to a material degree the adoption of aeroplanes by Ontario and other provinces in 1920.

The United States Government has recently brought about a co-operative plan between the military authorities of the United States Forest Service whereby Government machines will be tested in fire detection work during the present year.—[*Canadian Forestry Journal.*]

FORESTRY BILL.

[The following is reprinted from the *Times* of 8th July 1919, being the debate in the House of Lords on the second reading of the Forestry Bill.

We cannot but express surprise that while Britishers throughout our colonies and dependencies have recognized the value of forestry, the mother-country should have required the devastating effect of a world's war to bring home to our politicians that forestry on scientific and sound principles is equally possible and necessary within the British Isles.—HON. ED.]

The *Earl of Crawford*, in moving the second reading of the Forestry Bill, said he thought that the case for an afforestation policy in this country was generally conceded. During the last 25 years the matter had been the subject of numerous inquiries, but little or nothing had been achieved, and the position in the United Kingdom gave grave cause for apprehension. Only one other country in Europe was so sparsely wooded as was Great Britain, where the proportion of land under timber was only 4 per cent. while in Belgium 17 per cent. was wooded, in France 18 per cent. and in Germany 25 per cent. Portugal alone had a smaller wooded area than had Great Britain. Moreover, the woods here

yielded only about one-third per acre of that in countries where sylviculture was developed. We had enormous areas suitable for planting timber, and we had an enormously high percentage of woodlands which demanded reproduction. Even so the depletion had gone on apace. Before the war Ireland was losing about 1,000 acres a year, and his impression was that the same process was going on in Scotland and in England. When the war broke out there was an immediate shortage of timber and the whole market became disorganized. At one moment the continuance of our coal mining was gravely threatened owing to the inadequate supply of pit props, and a great tonnage effort had to be made. Timber was one of the most bulky of cargoes, and we paid a heavy toll of the mercantile marine for the timber which we had to import; we added to our debt and we burdened our exchange. In 1915 and 1916 the increased price which we had to pay for timber, compared with the price in the two previous years, was £37,000,000. He had not the figures for 1917 and 1918, but the prices continued fabulous.

The Bill asked for £3,500,000 to be spent during the next ten years to repair our losses and to provide for the future. Broadly speaking, the Bill was based upon the unanimous report of the Forestry Sub-Committee presided over by Mr. Francis Acland. The measure would constitute a small central body of seven members, to be known as the Forestry Commissioners, who would take over the powers and duties of the Boards of Agriculture in the United Kingdom, and would be invested with power to purchase or take on lease and to sell or exchange land, to make advances by way of loan or grant with a view to promote afforestation, to undertake the management or supervision of woodlands, to promote woodland industries, and to make inquiries, experiments, and research. The Commission would be empowered to acquire land compulsorily and to enter upon and inspect land. Three assistant commissioners would be appointed, one for England and Wales, one for Scotland, and one for Ireland; four consultative committees would be formed; and there would be divisional officers in charge of large tracts of country and district officers in

charge of smaller areas, who would be responsible for the foresters, foremen and woodmen. At first sight the organization might seem formidable, but it was not excessive in view of the work to be done. With a centralizing body, such as was proposed, there would be an economy in staff.

The general idea of the Commission was that during the first 80 years 1,750,000 acres should be afforested. The scheme of the Bill extended over only ten years, and it was hoped that during that period afforestation might be achieved as follows :— 150,000 acres by direct State action, 25,000 acres by proceed-sharing, 25 000 acres by local authorities and private individuals, and 50,000 acres of existing woodlands replanted, a total of 250,000 acres. He admitted that the scheme was made when prices were distinctly lower than at the present time, and either the money must be increased or the scheme be curtailed. Lord Haldane complained that Clause 8 of the Bill would place a large expenditure of public money outside the supervision of Parliament. That was not the desire or intention of those who were responsible for the Bill. Clause 8 stated that during the next ten years £3,500,000 should be paid out of the Consolidated Fund to the Forestry Fund ; but it would provide also that annual accounts of the Commissioners should be presented to Parliament, that the accounts should be presented to the Auditor-General every year, and that the Treasury should regulate the method of handling the money. One essential was that there should be some guarantee of continuity of policy, and to that end a centralized authority was necessary. Since 1909 the Development Commission had only been able to spend 10 per cent. of its money on afforestation, and during the five years before the war he doubted very much if more than 200 acres were planted. He thought that was natural and almost inevitable. It was not the fault of the Department. It was no good blaming public departments because the progress in afforestation had been so slow, because it was natural and inevitable that the agricultural side should obtain complete priority over the sylviculture. Therefore he thought that this centralized authority was very essential, and the administrative advantages

would be very marked indeed. Uniformity of survey would follow.

From the financial point of view the great advantage of a centralized authority was that it permitted a well-defined and far-reaching policy to be laid down. It avoided the annual wrangle and struggle with the Treasury about quotas for different countries. From the point of view of the Forestry staff, a central department would mean wide and rapid promotion and that prospect opened up a real future to the clever man. In education it would mean really a University instead of three or four isolated and detached colleges. The weight of opinion supporting a centralized scheme was overwhelming in England, and as far as he could ascertain it was equally well received in Scotland. It was remarkable what had been done in the last few months, and still more remarkable how keen the public response had been to the fact that at last it knew that an authority existed which was devoting its whole time and energy to the question of afforestation. A feeling of confidence and expectation had been aroused. People who had been waiting very patiently for 25 years at last realized that a great opportunity now presented itself. The Bill gave a permanent status to a Forest Authority from which great things were expected, and he had confidence in asking the House to give it a second reading. (Cheers.)

MOTION FOR REJECTION.

Viscount Haldane moved the rejection of the Bill in the following terms :—" This House, while fully recognizing the importance and urgency in the national interest of the reform of afforestation, declines to approve a measure which seeks (1) to withdraw the subject from control by the departments of Government already entrusted with it in England, Scotland, and Ireland ; (2) to divorce it from the local development of agriculture and of small holdings and the social surroundings they require in order to make any system of afforestation effective ; and (3) to place the very large expenditure of public money contemplated outside the supervision of Parliament " It was absurd to suppose that a scheme for setting up a bureaucracy in London could stimulate

the people of Scotland and Ireland. He emphasized the necessity of taking into consideration the social conditions of the people. They must encourage holders to settle down in small communities, often in regions very remote, feeling sure that they would find the social surroundings and stimulus which would induce them to accept the life. The Bill proposed to set up a body responsible in the matter of expenditure to no Minister in Parliament. The provisions for training and research were ludicrously inadequate. He protested that the money for carrying out the purposes of the Bill was taken entirely out of the control of Parliament, for the proposition was not that it should appear on the Estimates, but that it should be found out of the Consolidated Fund.

The *Earl of Crawford* pointed out that it was expressly provided by the Bill that the amount to be issued out of the Consolidated Fund " shall be such as Parliament may determine.'

Viscount Haldane was understood to say that this was not the same thing as the money being put on the Estimates. There was no Minister responsible to Parliament, and there was no means by which Parliament could get the efficient criticism when a matter came up on the Estimates. It was stated that there were to be two University centres for research but which were they to be ? The scheme was being initiated on too narrow a basis. The Government ought to have brought together the great landowners, great men of science, great teachers, and those who were interested in developing local communities. The House should not be led away by a false analogy. In France great State forests existed and all that had to be done was to maintain and look after them by people who were on the land. If sylviculture were to flourish here employment would have to be found for the people when they were not engaged in forestry which was not carried on mainly in that part of the year when there was most work to be done in agriculture. A number of other industries could be developed ; but the problem would not be solved by a sub-commission going from London to take charge of affairs. His objection went to the root of the Bill. The evil to be redressed was so serious that he shrank from placing any difficulty in the way of an attempt to remedy it but

he was convinced that the attempt was on lines which were too narrow, and that the Bill would lead to disappointment and embarrass the very process which it was intended to promote.

Viscount Clinton asserted that those interested in afforestation welcomed the measure as an indication that after many years of discussion the Government realized how serious was the position of this country in regard to the supply of timber. The cost which had to be met during the first years of the war owing to our deficient supply of timber had exceeded greatly that of the most extravagant scheme of afforestation which had been put forward, We were dependent upon imported supplies for nine-tenths of the timber used in this country, and while the demand was ever increasing there was little prospect of any additional supply. Practical people would not be willing to trust for a development of home-grown supplies to those methods which had been tried and found wanting. The Development Commission had spent upon afforestation only £250,000 including the amount of loans advanced although it had more money at its disposal. To carry on forestry properly you wanted not only knowledge, but interest and enthusiasm. Unless you had this you had not the driving force behind you to carry on the afforestation scheme. With regard to the financial clauses of the Bill, it had been said that grants or arrangements might be made with private owners for the carrying on of the work. It would be of enormous importance to the State if they could persuade owners to do some of the work. (Cheers.) We must have timber in the country in some way (hear, hear), and we must have it profitably if we could. It was quite clear that in the present case the most profitable way of growing timber would be to persuade someone else to grow it for you, even if they had to give them cash to persuade them to do it. (Hear, hear.) In his opinion grants should be made to owners to encourage them to get on with the work. (Hear, hear.) If the owner accepted a grant, the State should have a lien over the timber and be able to purchase it at any time.

The *Earl of Lancaster* said the war had convinced them of the absolute necessity of having a large supply of timber in this

country. If there was a genuine desire to make the country self-supporting in regard to timber, the great thing was not to set up a commission and appoint lecturers, but to employ people to dig holes and plant trees. (Laughter) He was afraid that the Bill was neither fish, flesh, fowl, nor good red herring. (Laughter) He did not know whether it was to teach foresters to go in for research or science or to supply the country with timber in the next 40, 60 or 80 years. The first necessity was that the Government should set to work to plant trees and help private owners to undertake the work. It was only right that the Government should deal fairly with owners with regard to taxation. (Hear, hear.)

A SERIOUS SITUATION.

The *Duke of Sutherland* said that the situation had become a very serious one. Travellers in the woodland districts of England or Scotland could not fail to notice the terrible bareness, he might almost say devastation, apparent in all directions. This was the ungrudging sacrifice made by this country to the war, but now the time had come to repair the evil and introduce a measure to co-ordinate the action of local authorities. There were great tracts of country where woodlands could be satisfactorily established and industry carried on He pointed out that period between planting and cutting was a very long one, and the men who sowed could never reap his crop. The landowner's future was such an uncertain one in this country that he naturally hesitated before embarking on a large capital expenditure for a scheme, the fulfilment of which he would probably never see. It was, therefore, a matter that must be taken up by the State on the lines of the Bill before the House. (Hear, hear.)

Lord Lovat, who was a member of the Reconstruction Committee and of the Interim Authority on Forestry, said they unanimously arrived at the opinion that the time had come when the trees ought to be put in the ground. (Cheers.) He thought it was quite certain that if they had one organization which would give a lead and an indication of the way in which research ought to go, there would necessarily be an absence of duplication of work

and they would have all the ground covered in a better and more efficient way than if they had three departments moving on uncontrolled lines. It was better to have one forestry service acting throughout the country as was the case in France and America. He did not wish to criticize either the Board of Agriculture or the Development Commissioners, but if we compared what had been done in Great Britain with what had been done in France, with its single authority it was really horrible. If we had had a single authority we should have saved probably millions of pounds by the prevention of the devastation of the woods which was going on at the present time. He denied Viscount Haldane's assertion that the question of research had been regarded from a niggardly point of view, and pointed out that from the first the Interim Authority had been in touch with the Imperial College of Science and Technology with Edinburgh and Oxford and Cambridge, and work was being done in certain directions which had not been done in all the ten years during which the Development Commissioners had held the reins of office. The amount of work to be done by the existing Boards of Agriculture in the several parts of the United Kingdom made it necessary that there should be a separate authority to devote the whole of its time to forestry.

The *Earl of Selborne* said that when he was President of the Board of Agriculture he realized that the existing machinery for dealing with forestry was wholly inadequate, and that unless it were centralized forestry could not be made a great national industry. When the war broke out it became necessary to set up a central body to deal with timber supplies. The position of this country would be perilous should we have the misfortune to be engaged in another great war within the next half-century.

The amendment was negatived without a division and the Bill was read a second time

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THE MANAGEMENT OF A TEAK FOREST.

In an article published in the *Indian Forester* for April 1919, I attempted to criticise the management of the unclassed forests of Burma, and ventured to suggest that our policy, while exceedingly expensive, fell short of perfection in that, in the near future, there was likely to be a serious shortage of timber for local requirements. It may, therefore, be of interest if I supplement this with a similarly frank expression of opinion on the management of the reserved forests maintained for export purposes.

The trend of opinion in Burma has set strongly in favour of converting our natural teak forests into even aged woods. The leading exponent of this view is a highly distinguished and able officer who, for many years, was Imperial Sylviculturalist to the Department, and in order to find out how he arrived at his conclusions, I have been reading what is really a beautifully illustrated text book on Forestry, but which he modestly calls "A Note on some European Sylvicultural Systems, with Suggestions for Improvements in Indian Forest Management," in which he expounds this view in more detail than I can find elsewhere. The reasons put

forward, however, strike me as singularly unconvincing. He has been a superspecialist in a branch of knowledge in which we are all specialists, and has been in a unique position to obtain information of sylvicultural work carried out in all parts of India and Burma, but practically his only argument in favour of conversion is based, not on experience gained in this country, but on the fact that in Europe the leading authorities have come to the conclusion that the selection system is unsuited to their requirements.

Forestry is purely a money-making affair like any ordinary business and therefore it is an axiom that the first consideration should be finance. Thus, before embarking on any big scheme, a sound business man would find out whether the finances of the firm could stand the strain and would make certain, not only that the scheme would yield a profit, but, as accurately as possible, what rate of profit. The other axiom of Forestry is that, as profits depend largely on the local conditions, these conditions should be very carefully studied. It is to the very thorough manner in which the financial results of any operation have been worked out, and the care taken to study local conditions, that European forest officers themselves attribute the very high standard of excellence attained on the Continent of Europe, and I maintain that in Burma Forestry is in a most deplorable state of muddle owing to the wilful disregard of these axioms.

To give a few instances, I do not think it can be denied that indiscriminate fire-protection was undertaken in Burma merely because the leading authorities on Forestry in Europe had come to the conclusion that it was essential to keep fire out of a European forest. The conditions in Burma and Europe are, however, utterly dissimilar, and as no attempt had been made to work out the financial results of this operation, it was from a business point of view a senseless gamble, which, however, like any gamble might have turned out well. The disastrous effects of this operation have gradually become apparent, and most forest officers will now, I think, admit that, in this case at least, the wilful disregard of these axioms has resulted in a waste of many lakhs of rupees.

Even from a business point of view there was a certain amount of plausibility in the idea that teak might thrive better if fire were excluded, but every forest officer knows that every tree, whether light demanding or shade enduring, requires light for development, and to my mind it is very characteristic of the ideas which prevail in Burma that whereas without exception every teak sapling growing in a plantation receives the attention it requires, not once, but at regular intervals throughout its career, the chance of any natural teak sapling receiving any attention at all is negligible.

There are in the Katha Division two reserves which, owing to their diminutive size, absence of bamboo, and presence of patches of pure teak, are quite abnormal, and in my view these reserves should be quite the last place to select for carrying out experiments to determine the most suitable method for working a teak forest. These forests, however, in many ways resemble a European forest, and it is, apparently, entirely for this reason that whenever a forest officer is posted to that division, he immediately sets to work most busily on those reserves.

This activity contrasts most curiously with the vacillation and indecision displayed in the case of an ordinary teak jungle. Usually nothing is done but occasionally a few keen individuals will set to work, in the most pathetic manner, in creating odd little patches of pure even-aged woods of the type to which they were accustomed in the period before they were fledged. It is useless pointing out that according to enumerations the seedling class already greatly predominates in numbers, and that they are unable to protect from suppression the young teak saplings and poles already on the ground. They seem unable to take advantage of work already completed and seem impelled to make a fresh start from the beginning.

The author of the treatise referred to was at one time converted to what I consider the orthodox view. It was he who, breaking away from the traditions of the Service, collected statistics showing the disastrous effects of fire-protection on the natural regeneration of teak, and thus delivered the first shrewd blow from which the advocates of indiscriminate fire-protection never

recovered. It is all the more sad, therefore, that he should have backslidden, and should have used the great influence of his position to denounce methods solely on the grounds that these methods have proved unsatisfactory in Europe.

I admit that European forest officers thoroughly understand their own business, and as they consider the selection system unsuited to their requirements, it may be inferred that there is some sensible reason for their objection. The explanation is very simple. In Europe *it is usual to cater for the requirements of* small towns, the markets of which are readily disturbed by irregular supplies. Generally prices rule higher in the small towns than in the large import towns, and as timber is costly to transport, irregularity of supplies reduces the profits both ways. Under the selection system in Europe, however, a considerable degree of irregularity of the yield seems inevitable. Theoretically under this system a normal forest is one which contains a normal series of age gradations, but in practice there is insufficient evidence to determine what the proper proportion of trees in each class should be, and further, having arbitrarily fixed on certain proportions as a standard, it is almost impossible to carry out the thinnings in such a way as to attain or maintain those proportions.

The main, if not the only, objection to the selection system in Europe is, therefore, that under this system it is impossible to ensure the high degree of regularity of yield which is considered essential in order to obtain the highest rate of profit.

In Burma, however, these considerations do not apply. In the first place, as I shall endeavour to show later, our forests are perfectly normal. But apart from this, practically the whole of our outturn is exported to the European and Indian markets, and therefore assuming a similar irregularity of the yield, in Burma as in Europe, we may reckon on the fact that part of the irregularities of individual forests would cancel out in the provincial outturn and that any remaining fluctuations would not seriously disturb the world's markets. As a matter of fact, even from forests in which the exact number of trees to be girdled annually has been definitely prescribed, the actual outturn varies very greatly owing to the

enormous differences in the floating seasons, and it is a matter of common knowledge that these fluctuations of outturn exercise very little influence on the price of teak. To abandon a system which is in many ways admirably suited to an undeveloped forest on account of a doubtful theory that under another system a higher degree of regularity of the yield would thereby be ensured, seems to me to be the height of absurdity.

Nevertheless the main objection to conversion is that, although intended ultimately to ensure a more regular and sustained yield, it would actually have the contrary effect. In considering the question of forest management, the outstanding fact to be borne in mind is that in the ordinary course of events we have to expect a very serious decrease of outturn as soon as the existing surplus of overmature trees has been removed. As the period is usually fixed at 30 years and the exploitable size at 7′ 0″ girth, the normal yield consists of trees ranging from 7′ 0″ girth to 7′ 0″ plus 30 years growth or roughly 8′ 0″ girth. It is the practice, when girdling, to enumerate all trees over 6′ 0″, and I am therefore able to give the following figures for the teak in an area girdled over in a typical division in one year. Actually 11,851 trees including 2,854 immature trees were girdled, but the total growing stock of trees both girdled and left was as follows:—

6′ 0″ to 6′ 11″	... 5,822 trees
7′ 0″ to 7′ 11″	... 5,095 „
8′ 0″ and over	... 8,384 „

The normal annual yield is therefore about 5,000 trees, but the surplus of overmature trees is even in number of trees very much greater than the normal yield, and if volume is taken into consideration about double the normal yield. There is a similar surplus in every teak forest, and as in every case it has been arranged that the whole of the surplus shall be removed by the end of the second period, and as with few exceptions the second period will have expired some 50 years hence, we may calculate that by that date the provincial outturn of teak will have fallen to about a half what it is at present.

We already spend about 40 per cent. of our revenue, and some 50 years hence, when the outturn has been reduced to a half the proportion will automatically be increased to 80 per cent., assuming that the expenditure remains the same. Any scheme of conversion, however, instead of sustaining the yield at this critical period, must tend to increase the difficulty. For instance, assuming that it is attempted to convert half the forest in the first rotation of 100 years, in 50 years a quarter of the area will have been rendered unproductive of teak for the European market, and therefore reduce the revenue a further 25 per cent.

As regards expenditure, we speak lightly of conversion, but as teak forms a very small proportion of the growing stock, conversion actually means reafforestation, which, considering the enormous areas involved, must necessarily be an extremely expensive process. In the case of taungya plantations in Lower Burma, it was found that, although at first everything went smoothly, the taungya-cutters doing all the work with little supervision, yet that after some 30 or 40 years the work became so great that the practice of creating even-aged woods had to be abandoned. We have now a much larger and better establishment, but it is proposed to conduct operations on an infinitely larger scale, and, judging from this experience, it seems certain that the cost of continuing conversion and the enormous staff required to tend the large number of even-aged woods created will, some 50 years hence, place a great strain on our finances and establishments, and combined with the serious decrease of revenue, will result in a state of financial chaos. Theoretically, in a further 50 years the balance would be restored, and an outturn obtained even higher and more regular than at present and more easy to extract, but this would be a poor consolation, if in the meantime the department had become discredited and bankrupt.

On the view that it is essential to study the local conditions, by far the most important feature of these forests, and the one which in particular distinguishes them from the forests of Europe, is that they are natural forests, and it follows, therefore, that one

may avail oneself of the considerable mass of knowledge which has been acquired by a study of Natural History. In the case of man it is a matter of common knowledge that many calculations, such as those relating to insurance and conscription, are based on the fact that man is arranged in what we call in Forestry "a normal series of graduations," and everyone is familiar with the explanation that this is due to the incessant struggle which man may be said to be waging with disease, the forces of Nature being so nicely balanced that the mortality at each period of age remains constant. In a natural forest all species of trees undergo a more direct and more severe struggle for existence, and therefore we may, I think, assume that a similar state of uniformity must prevail. We know that each species of tree produces approximately the same amount of seed annually, and therefore it is easier to understand that the regeneration of a tree should be normal than that the birth-rate of an animal should be constant. Similarly in the case of a tree the mortality depends mainly on growth, which is a constant factor, and each generation is exposed to the same perils, such as a dense growth of bamboo in one locality or thick grass in another, and therefore it is easier to understand that the mortality at different ages should be constant than in the case of man where the principal causes of mortality are due to invisible microbes. We are, therefore, I think, safe in assuming that in a virgin forest each species of tree must be maintained in a state of equilibrium or balance, and that each species must be arranged in a series of normal age gradations.

The classes adopted for working-plan enumerations are irregular and make it difficult to trace the gradations, but so far as they go, the statistics support this contention. Whereas in an artificial forest, which is seldom perfectly normal, the older age classes frequently contain more trees than some of the younger classes, in Burma it is invariably found that the numbers are graduated in the manner one would expect on this view.

Assuming therefore that teak is arranged in a series of normal age gradations, it is merely necessary to determine the distribution of teak throughout a forest and to divide the forest

into 30 coupes, each of which contains approximately one-thirtieth of the growing stock of teak to ensure a regular yield to the end of the rotation. Just as in the case of conscription, it may be assumed that when the number of recruits available for training from a country or district has been determined, the same number will be available in future years, so in the case of teak we may concentrate our energies on enumerating the exploitable trees, and may rest assured that there will be sufficient trees in the younger gradations to maintain the normal yield. Personally I would enumerate all trees over 5′ 0″ in girth over 25 per cent. of the forest in four classes, a 5′ 0″ class included only to ensure all trees over 6′ 0 being enumerated, 6′ and 7′ classes from which the normal yield could be calculated, and a class of trees 8′ and over from which the surplus could be calculated. As large trees are comparatively few and easily seen, the work would be inexpensive and could be carried out by any intelligent Forest Guard. With 8 or 9 enumerators, preferably working independently, I would detail one or two more senior subordinates to recount selected sample plots with a complete series of foot classes for the purpose of checking the original enumerations, providing data for working out an actuarial table of the natural normal mortality, and assessing the appreciation or deterioration of the forest in future years.

With a 25 per cent. enumeration it should be possible to obtain a very accurate estimate of the yield, but under present methods the cost of a working-plan works out to over Rs. 100 per square mile, which is about one rupee for each exploitable *tree actually counted (which is obviously a bit stiff) and even so* it is notorious that the estimates are hopelessly inaccurate. The calculations of the yield are usually very elaborate, but palpably incorrect. For instance, in the plan of the forest in which I am working, it is calculated that, although only 118,124 first class trees were enumerated, 130,251 trees will be available for exploitation. This result is obtained by calculating that even in a 24 year period a large number of immature trees will enter the first class before girdling takes place, and that there

will be an absurdly low rate of mortality among the first class trees. Seeing that these forests have been practically untouched, it is not clear why on this rate of increase the forest does not contain mature trees and nothing else. Similarly the working-plans officer has allotted fewer trees to the coupes to be taken in hand towards the end of the period.

As regards the revision of a plan at the end of the first period, it is possible, while girdling, to obtain an extremely accurate idea of the distribution of teak throughout a forest, and therefore it should be possible to make adjustments so as to ensure a far higher degree of equality of the future yields. Obviously also, the volume which could be accurately determined should also be taken into account. On my view a full 25 per cent. enumeration would be unnecessary, but it would be essential to enumerate the teak in the series of standard sample plots, comprising about 2 or 3 per cent. of the area, in order to assess the deterioration or appreciation in value of the growing stock. I attach the greatest importance to this as if once forest officers could be brought to realize how steadily the forests were deteriorating under their management, there would be some chance that existing methods would be overhauled.

A large number of plans will shortly expire, and on the assumption, which seems to me ridiculous, that the department is terribly undermanned, there seems every indication that the revision of these plans will be carried out in a very casual manner, and I hope, therefore, nothing I may have written will be taken to justify such methods. I have been discussing Forestry as it might be, and not as it is, and in most cases girdling has been carried out in a very irregular manner, and little attempt has been made, while girdling, to determine accurately the distribution of teak.

The Research Institute has classified our working-plans into a large number of systems of management, but in view of the fact that our working-plans consist merely of a felling scheme, I venture to assert that management in the true sense of the word has not yet been started in Burma. Taungya-cutters, who frankly regard the forest as so much manure, often carry out fellings just

as systematically and under a definite rotation, but they do not profess to be undertaking forest management The management of a forest consists of much more than the preparation of a felling scheme, and as in agriculture comprises sowing, tending and reaping operations.

On the whole the felling scheme of teak forest is based on sound principles The yield is restricted to the productive capacity of the forest, the whole forest is gone over systematically and within a period sufficiently long to allow a new crop of trees to attain maturity, and the annual coupes are arranged in such a way as to furnish regular and equal yields In fact the standard is so high as to make it practically certain that the original lines *were laid down by one of the three German forest officers who* joined the department, and brings into glaring contrast the inadequacy or absence of felling schemes for species other than teak, and the lack of any suitable sylvicultural scheme to supplement the felling scheme

As regards the principles which should be observed in preparing a sylvicultural scheme for a forest, I would point out that a forest should be treated as a whole, and a uniform system of treatment prescribed. This does not prevent two or three separate methods of treatment being applied, but it precludes, for instance, fire-protection being applied to one part of the forest and the remainder left unprotected, or two or three compartments being treated in a very intensive manner and the remaining area entirely neglected. In lectures on Forestry it is usual, when expounding this principle, to refer in a jocular manner to the case of the dear old gentleman who potters about his estate, and whenever he finds a suitable spot, dibbles in an acorn, and, making allowance for the difference in scale, it is rather amusing to find that this example is faithfully followed in the way taungya plantations are frequently scattered haphazard throughout a reserve. This sort of thing indicates a most excellent spirit, but does not make for uniformity which in forestry is so essential.

It is also necessary to realize that the proportion of revenue devoted to the maintenance and improvement of the capital

value of a forest should be a reasonable one. For instance, in the case of the famous Mohnyin reserve the proportion is far too high, while in the case of an ordinary teak forest the proportion is far too low. Both are equally serious mistakes. In a typical teak forest the yield per acre is small, and therefore it follows that any scheme of sylvicultural operation should be, although adequate, extremely simple and inexpensive This is the most difficult point for any Englishmen, or even Scotchmen, who with their greater acumen in financial matters generally display a greater aptitude for Forestry, to realize, as we are on this point so greatly led astray during our course of training. In Europe every forest is fully stocked with valuable species, and in order to obtain the highest nett profit per acre, very intensive forms of culture are indicated, and within limits expense is no object, provided that corresponding results are obtained. In Burma, however, teak only forms a small proportion of the growing stock and therefore our object is entirely different, namely, to increase the yield per acre, and with a small expenditure to obtain the greatest possible result.

As I have already pointed out, we have to anticipate an exceedingly serious decrease of yield some 50 years hence, and therefore it is indicated that we should take steps to sustain the yield at that period. It may also be noted that, as the effect of removing a large proportion of the seed-bearers of one species only is to reduce the regeneration of that species below the normal, we should take steps to counteract that effect.

As regards the actual methods to be adopted, I do not think we can do better than again seek inspiration from Natural History, and to my mind the most apposite case is game preservation as practised in England. Here we have the case of a species occurring naturally, of which it has been proved that the stock can be increased to such an extent that large numbers of game can annually be killed on an estate where formerly the game was very scarce

The means adopted are the reduction of the natural normal mortality to which the species is subject, and only in the case of

exotics, or where money is no object and it is desired to raise a particularly large head of game, artificial rearing.

In the case of teak the fact that a tree planted in a compound or avenue is practically certain, unless deliberately cut down, to attain large dimensions, proves that the only serious cause of mortality to which teak is subject is due to the competition of the species with which it is associated, and it is therefore indicated that we should go systematically round our forests and, so far as possible, free all suppressed trees. I do not think, however, that it would be possible to eliminate all mortality. For instance, although teak is popularly supposed to be a light demander, one often finds etiolated seedlings in the most unpromising positions, and although it might be possible to free even these by repeatedly cutting back the bamboo, etc., the expense would not be justified. For practical reasons I do not think it would be possible to get over the whole forest in less than ten years, and therefore I would restrict operations to freeing only those trees which, with a reasonable amount of assistance, would be likely to carry on for another ten years. This would include practically every tree over 3′ 0″ girth. Most of such trees have penetrated the bamboo canopy, and, if freed, it is most unlikely that they would again be overtopped by other trees growing from below. Not only is "the present worth" of such trees relatively high, but the cost of ensuring that they will reach maturity is comparatively low, and therefore the operation is highly profitable. In addition it might be worth while to give some assistance to some of the more promising poles and saplings. Assuming that whereas at present, say, 10 saplings win through the bamboo canopy without any assistance, it is reasonable to suppose that with a certain amount of assistance a further 10 or 20 saplings could be assisted into the overwood. Generally, however, it is only proposed to attempt to control the tree growth, partly because this gives greater results for a limited expenditure, and partly because of the urgency of sustaining the yield at the critical period about 50 years hence. Later on, however it may reasonably be hoped that the manufacture of paper-pulp from bamboos may be largely developed, when by regulating extraction,

it may be possible also to bring the bamboo growth under control.

The cost of such operations varies with the density of teak, and therefore with the revenue, which is a consideration, but on an average works out to about Re. 1 per acre, and this would be materially decreased if some method could be discovered of killing softwood trees without felling, *i.e.*, by girdling and painting on the band some composition which would be absorbed into the tissues and kill the tree. On an average the revenue from teak forest is about Re. 1 per acre per annum, and therefore with a rotation of ten years the expenditure works out to about 10 per cent. per acre per annum. Allowing a further 10 per cent. for cost of supervision, the expenditure amounts to 20 per cent. of the revenue, which is not an unreasonable proportion to devote to the maintenance and improvement of the capital value of a forest.

I cannot, of course, prove that these operations would yield "the maximum results with the minimum expenditure," but I can at least give what I consider sound reasons for thinking that very appreciable results could be obtained at a comparatively low cost, and if anyone can show that still better results could be obtained by other methods, so much the better. For mathematicians the following table prepared by the Research Institute from a large number of enumerations may be of interest:—

Girth.	Corresponding Age.	Proportion of Trees.
6′ to 7′.	130 to 155	5
4′ to 6′	90 to 130	10
3′ to 4′	58 to 90	17
Under 3′	1 to 58	61

A census according to ages naturally forms an actuarial table of the mortality to which man is subject, and similarly an enumeration of teak by age or girth classes must, I think, form an actuarial table of the natural normal mortality to which teak is subject. This table therefore gives a basis for calculation. Except in the rare cases where teak competes with teak, practically all the normal mortality over 3′ 0″ girth could be eliminated and a proportion of that below 3′. The Research Institute also

calculates that in a natural forest the growth even of those trees which successfully win through to maturity is retarded by suppression, and that by giving trees a reasonable amount of room, the time taken by the average tree to reach maturity could be reduced to 100 years, and allowances must be made accordingly. Again it is known that a large proportion of trees suffer injuries owing to suppression, and are bent over or deformed, in fact a perfect tree is an exception, and therefore the value of the average tree could be increased by preventing these injuries.

These calculations are, however, rather abstruse, and the ordinary individual may perhaps better realize how effectively the proportion of any species may be altered by imagining an attempt to exterminate all teak over a given area. For instance, in a compartment where teak formed about 5 per cent of the growing stock, a smart gang of coolies could, I think, in a very short time, fell every single teak tree, sapling and seedling. The work would probably not cost more than about Re. 1 or Rs. 2 per acre, and it can hardly be doubted that in a year or two the jungle would completely close in leaving no trace of the teak. To increase the proportion of a species is, however, just as simple as to reduce its proportion. We know that teak is exceedingly responsive to light, and it is found in plantations that 1,000 seedlings per acre dwindle down in 100 years to 20 trees which means that in this time teak increases 50 fold the proportion of the area it occupies and therefore it is obviously just as easy to favour the teak at the expense of the jungle as to let the jungle encroach on the teak, and to increase the percentage from 5 to 10 per cent. as to reduce it from 5 to nil.

There remains the question of natural regeneration which apparently causes so much anxiety. We know, however, that the mortality due to growth is very great. As pointed out, in a plantation the trees gradually dwindle down from 1,000 per acre to 20 in a period of 100 years, which means that for every tree which reaches maturity 50 become casualties for want of room for growth, and although in a natural forest the natural normal mortality, as proved by the actuarial table put forward,

is surprisingly small, it is nevertheless clear that sufficient trees could be saved which would otherwise die a so-called natural death, not only to restore the balance, but to increase the natural regeneration by an amount which would be equivalent to a considerable area of taungya plantations.

An officer acquainted with my views, but not with Burma, very kindly wrote to me and pointed out that he failed to see that any possible harm could follow from establishing artificially a full crop, preferably mixed, by the uniform system, not necessarily in one compact block, but wherever the conditions of the growing stock justified it, at the same time carrying out improvement fellings and thinnings on the rest of the area so as to ensure the future yield to the rest of the rotation. He considered that we should have the higher value of our yield, when concentrated by the uniform method, as a set-off against increased cost of formation, and that the skidder would replace the elephant and mechanical means of transport rendered possible. He added that we must set aside difficulties of staff as these must be overcome.

At the outset, there is, I think, a tendency to confuse the fact that our forests are uneven aged with the fact that they are also incompletely stocked with marketable species. I understand that in America, where mechanical transport is more largely used than in any other country, the forests are, without exception, uneven aged, and this tends to prove that mechanical means of transport are not dependent on the adoption of the uniform system.

In the elephant we have a very powerful animal which abounds in Burma, can without great difficulty be caught and trained, and costs little to feed. Ordinary labour is comparatively cheap, and we have an excellent network of floating streams. On the other hand, mechanics are comparatively expensive and, when sick, difficult to replace, and the country is so broken that it is difficult even to make well-graded bridle-paths. Anyway, so far as I am aware, no real expert has expressed an opinion that were clear fellings made or the uniform system adopted, mechanical means of transport dependent on a prepared track would be a sound business proposition, and while indulging in futurism, why not go

the whole hog and have visions of timber being extracted by airships, in which case the accumulation of large quantities of timber at one place would not be necessary? The conditions are very different in the case of the more accessible forests in the foothills where extraction could be carried out in connection with the railways, but forest officers in Burma only contemplate the adoption of the uniform for the teak forests on the main watersheds, and propose to retain the selection system for the forests from which local needs are met.

In order to obtain a large stock of teak, there is, in my opinion, not only no harm in a system of teak preservation combined with artificial rearing, but, on the contrary, I should be only too pleased to see such a scheme taken seriously in hand. The only little difficulty I can suggest is the matter of funds to finance such a project. The teak forests of Burma are, as it were, a gift of the gods, and not our own handiwork, and as the Province is sadly in need of funds for many purposes, it is only reasonable that the present generation should derive a certain amount of benefit from these forests. On the other hand, we hold these forests in trust, and it is only right that we should hand them on to the next generation with their capital value intact or, if possible, considerably improved. On the whole I think 60 per cent. of the revenue, the maximum we can hope to retain for this purpose, and anything from 40 to 60 per cent. a reasonable allotment. I do not think, however, that it is generally realized that when a species commands a high royalty value, a low allotment is indicated. It is equally desirable to maintain the supply of a timbe with a low royalty value as one with a high value, but unfortunately the cost of sylvicultural operations does not vary with the royalty value. Thus in a teak forest yielding annually a revenue of Rs. 4,00,000 at Rs. 20 a ton, an allotment of 40 per cent. would allow Rs. 1,60,000 for expenditure but in a Pyingado forest yielding exactly the same volume of timber with a royalty value of Rs. 5 per ton, the revenue would be only Rs. 1,00,000, which even with a 60 per cent. allotment would only permit of an expenditure of Rs. 60,000. The point is of

some importance as we have devoted ourselves hitherto mainly to teak forests, and there is every prospect that in the near future a trade will be developed in inferior timbers, in which case we shall be called upon to maintain the supplies. In my opinion, therefore, we should, in the case of teak, endeavour to keep down to a 40 per cent. allotment, and what is more to the point is that hitherto the Local Government has not shown any disposition to grant a larger allotment.

We already spend, however, about 40 per cent. of the revenue and of our expenditure very little is devoted to sylviculture, and when therefore it is lightly suggested that we should embark on a magnificent scheme of conversion and at the same time carry out improvement fellings systematically over the remaining area, the humour of the situation from my point of view lies in the fact that, although the question of finance should be a forest officer's first consideration, it is evidently the last thing he thinks of.

The scheme I have put forward is in comparison extremely humble, but to enable, even this scheme to be carried out, I consider it would be necessary completely to overhaul our finances, especially those in connection with the management of unclassed forests, to reorganize our establishments for forest works, and to create an efficient labour supply, and in particular we should have to revise our ideas as to the amount of labour we can effectively supervise. To restrict the yield of a forest to its productive capacity and to carry out sylvicultural operations to ensure the maintenance and improvement of the capital value of a forest is the essence of Forestry, but there are few cases in the British Empire where such an object has been attained, and I consider the chances of attaining a fair standard of Forestry in Burma are now extremely remote.

The only little matter which seems to cause anxiety is "the paucity of establishment," which will probably be remedied in the near future. In this connection a few statistics derived from the last quinquennial report for the years 1909—1914, *i.e.*, before expenditure on sylviculture had been reduced owing to the war, may prove of interest. During this period the average annual

revenue was Rs. 1,04,20,259 and expenditure Rs. 40,69,971, or rather under 40 per cent. The amount spent under B, establishments, was Rs. 21,02,468, or about 51 per cent. of the expenditure, while the amount spent under subheads A VIII e, f, and g, which include all works which by any stretch of imagination can be called sylvicultural operations, was Rs 4,02,613, which is under 10 per cent of the expenditure and under 4 per cent. of the revenue, more than half of which was incurred on fire-protection. Incidentally in the previous five years, from 1904 to 1909, the expenditure under B was seven lakhs less, while the amount spent on sylviculture was half a lakh more, which affords food for reflection.

Judging from these statistics the principal function of the Forest Department is to provide comfortable billets for as many deserving persons as possible, but the department was orginally created for the purpose of maintaining and increasing the valuable teak supplies of Burma, and it may be of academic interest, some 50 years hence when the effect of our management has become apparent, to reflect how such an object could have been attained.

H. C. WALKER, I.F.S.

July 1919.

LUMBERING IN THE UPPER SUTLEJ VALLEY (PUNJAB).

PART I.

There is at present a very general shortage of timber throughout the Punjab owing to the depletion of stocks through export to various theatres of war operations during the last few years. Coniferous timber is in great demand by the Railway for sleepers, by the Military Works, and by the general public, and it may perhaps be of interest to describe lumbering operations now being undertaken by the Forest Department in the Bashahr Division.

Traders' Leases.—For many years timber was extracted by Government agency, mainly in the form of logs, till in 1908 a lease of the main fellings was given to the Sutlej Forest Company, which lease after various extensions terminated on August 31st, 1918. The deodar forests were worked to their full annual yield as

provided in the Working Plan, the more accessible blue pine forests were cut over, some of the chir forests were worked, but the very extensive spruce and silver fir forests were practically untouched.

Log working was soon abandoned by the Company as logs take at least two or three years to reach the sales depôts in the plains and the consequent heavy interest charges and the expense of building rolling roads proved too great for the Company's finances. The rapid increase in the price of the deodar railway sleeper rendered returns from sawn scantlings more certain and profitable and the Company converted the whole of its outturn of about 10,000 tons annually to sawn scantlings.

Some of the work done by the Company, notably in floating scantlings in permanent or telescopic slides past cataracts in side streams, and in the designing and utilization in precipitous country of simple portable wire ropeways up to 3,000 feet span was of a high standard.

Reversion to Departmental Extraction.—In September 1917 departmental extraction was reverted to and orders were received to increase the supply of timber to the maximum extent possible in view of the urgent requirements of the Indian Munitions Board.

The Bashahr Forest Division consists of the Leased Forests of the Bashahr State, and, commencing from fifty miles north-east of Simla stretches to Thibet, and contains the forests of the Upper Sutlej Valley. The river cuts through the mid-Himalayan range and the forests lie on steep to precipitous slopes and in the catchment areas of side streams, the forests in the main valley generally being separated from the river by three or four thousand feet of precipitous and bad ground. The country and local conditions have been described in the *Indian Forester* for the month of November 1915 in an article entitled "Fifty Years of Forest Administration in Bashahr"; for the purpose of this article it is sufficient to note that the country is probably the steepest and most precipitous in which lumbering operations have ever been attempted, that worse floating streams do not exist, many of them being so bad as to render floating of scantlings impossible and absolutely to prevent the floating of logs.

LOGGING OPERATIONS.

Export of timber in the form of logs from the remote forests of Upper Bashahr has several advantages, chief of which are that the local labourers thoroughly understand log work whereas they are useless for scantling work, the import of food supplies is reduced as local logging gangs provide their own food, less wastage of timber occurs in the forest and less breakage in the river, and deodar and kail logs of all sizes fetch very high prices in the plains where they are in great demand.

Mature deodar and kail trees occur for the most part in scattered woods, most of which have been worked over before, and are consequently in an advanced stage of regeneration. There is, therefore, no chance of the introduction of expensive machinery proving profitable in the deodar and kail forests owing to the operations not being sufficiently concentrated. The chief problem is to control the logs by manual labour to such an extent that they do not smash themselves in the precipices or damage advance growth in their journey to the rivers. It may be noted, however, that in the case of the extensive virgin spruce and fir forests hydraulic-electric machinery may shortly be introduced.

Felling.—Felling is always done with the axe, it being found quite impossible as well as undesirable to use the saw on the steep slopes on which the trees stand. All trees are lopped to the top before felling, and in order to direct their fall a rope is almost invariably used, consisting of a 3½ inch circumference manilla rope about 180 feet long for all big trees and a 2½ inch circumference manilla rope for smaller trees of 6 feet and under in girth.

Trees are in nearly all cases felled directly uphill in order to save breakage of timber. The axe-cut is made at right angles to the line of greatest slope straight across the stump and the cut on the upper side of the tree is driven at least two-thirds across the stump, which on its uphill side is not more than six inches high and is more often flush with the ground. Above and parallel to it on the lower side of the tree a second cut is then made, at the same time a strain being placed on the rope, one end of which is lapped round a standing tree. The second axe-cut is extended

and the strain is gradually increased by members of the felling gang so that the fall of the tree is guided directly uphill. This method results in the minimum damage to the tree itself as it generally rests with its butt on the stump, and if, by any chance, it jumps its stump, as occasionally happens, it comes to far less damage by plunging downhill butt-end foremost than if it had started from a horizontal position. By falling straight uphill a lopped tree can only plough a clean line through advance growth which is consequently rarely badly damaged damage generally resulting when trees are felled criss-cross and without lopping. The success obtained in saving timber and in not damaging young growth completely vindicates the rather strict rules enforced by the Department in traders leases in the Punjab.

Trees are felled in directions other than uphill only when they are liable to break on rocks immediately above these or when there are particularly valuable patches of advance growth which it is desirable to save. As a general rule the ground is far too steep to allow departure from this practice without risk of smashing the falling tree to pieces.

Logging.—Logging is done with an ordinary cross cut saw, the logs being first measured and their lengths marked off on the tree by the Moharrir in charge. The nature of the ground, and especially the number of rocks in the rivers, render it impossible to work out logs of greater length than 16 feet, while logs of 12 to 15 feet girth and upwards are brought down in 12 feet lengths.

Rolling Roads.—The construction and form of rolling roads have not altered considerably since Colonel Bailey described them in the *Indian Forester* in 1889. They consist of well-graded roads of about 12 to 14 feet in breadth and 1 in 10 gradient, and their object is to enable logs to be brought round and above precipices on to the shoots. The retaining walls are made with wooden binders and stone and on the surface of the roads poles are laid parallel to one another over which the logs are rolled. Logs are brought on to these rolling roads from the earthen shoots or slides and are rolled over and over by means of wooden levers, care being taken to prevent them getting up speed or falling over

the edges. This is slow work and the cost rises more in proportion to the length of the rolling roads than to the length covered by the shoots; but on the proper planning and alignment of the rolling roads depends the successful extraction of the timber.

Shoots.—In easy ground earthen shoots are used with a few check-walls, the latter becoming more numerous on steep ground, and down these shoots the logs are worked butt-end foremost with the help of wooden levers.

The check-walls consist of vertical baulks of timber four to five feet in girth, walled in with rocks so as to form strong buttresses against the impact of logs.

On steep slopes the greatest difficulty is experienced in preventing logs getting up speed, as it can easily be imagined that when a log weighing two tons once gets a move on, it smashes down everything in its course and finally dashes itself on rocks hundreds of feet below and is splintered to matchwood. Fortunately the logging gangs are very expert and fearless at this work, and as separate gangs are maintained for repairs to check-walls the percentage of logs badly damaged is extremely small.

I am sorry that the photograph (Plate 29, Fig. 1) does not give a better idea of a log travelling down a shoot on a steep hillside, but confess that it takes a braver man than I am to carry a camera in closer proximity to a steep shoot. The shoot in the photograph Plate 29, Fig. 2 is particularly dangerous on account of the rocks, which are continually loosened by the impact of the logs and crash down the hill.

Wooden Slides.—The shoot often ends above a precipice down which it is impossible to allow logs to fall and above which a very substantial check-wall is erected. Leading from the check-wall is a wooden slide formed of poles morticed to cross-pieces and ending in earthen pits into which the logs shoot. The photograph (Plate 30) gives a better idea than a written description of the way in which slides are taken through precipices after blasting a passage on which the slide rests.

Floating.—Logs are collected in lines near the river bank and are then branded and measured up for payment on a cubic foot

Fig. 1. Logs on a rolling road.

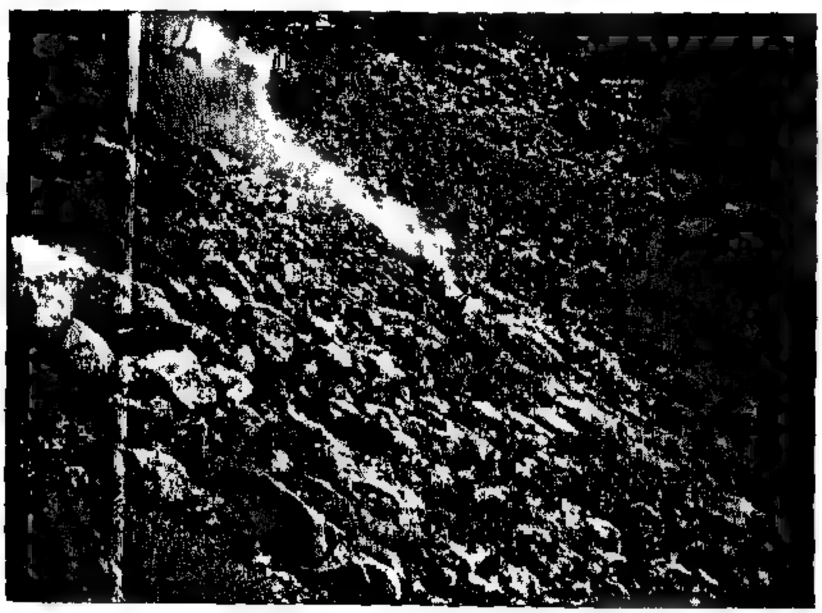

Photo. Mechl. Dept., Thomason College, Roorkee.

Fig. 2. A log shoot

Photo.-Mechl. Dept., Thomasson College Roorkee.

Fig. 3. A LOG SLIDE THROUGH A PRECIPICE.

basis. They are then pushed into the river and wait for the first spring floods. The Sutlej river is impassable to logs at low water on account of the numerous rocks and cataracts in its channel. These are covered in the summer and logs have to wait for the melting of the snow and the rise of the river.

Except for clearing jams and relaunching stranded logs the logs are left to themselves until they reach the catching depôts commencing where the Sutlej debouches from the hills. Here they are tied into rafts and are taken to the Sales Depôts on the North-Western Railway where they are carefully classified and sold.

Cost of Operations.—It is too soon as yet to give the cost of the present logging operations, as most of the 9,500 logs launched in 1918 are still in the river owing to the exceptionally low level of the Sutlej and Baspa rivers during 1918, caused by the failure of the winter snows and monsoon rains.

The following is the cost of old logging work as given in the Sutlej Valley Working Plan published in 1905:—

Cost of rolling roads and shoots ..	2 3 pies per cubic foot of timber received in sales depôts.
Cost of felling, logging and working down logs to the river.	One anna to one anna six pies per ditto.
Cost of rafting, etc. ...	One anna six pies per ditto
Total average direct cost exclusive of establishment expenses.	2·58 annas per ditto.

The cost of labour has risen in the last ten years, but the working expenses have not risen so rapidly as the sale prices of timber in the plains, and there can be no question but that the working of timber in the log is most profitable.

At a recent open auction in March 1919 first-class deodar logs realized a record price of Rs. 3 per cubic foot, and although it can hardly be expected that these prices will continue, there is little fear of Government not making a handsome profit on its lumbering, so far at any rate as logs are concerned.

(To be continued.)

June 1919. H. M. GLOVER, I.F.S.

PLANT DISEASES.

In the *Indian Forester*, Vol. XLI, 1915, p. 1, it is stated "of recent years there has been a decided tendency to exaggerate the importance of fungi and to regard them as being the primary cause of most plant diseases. It is believed that this point of view has at once obscured the real causes of many diseases and delayed the application of effective remedial and preventive measures, inasmuch as vital factors, such as soil moisture content and soil-aeration, are frequently easier to control on a large scale, both in agriculture and forestry, than are injurious fungi." In the *Kew Bulletin* for 1913 (pp. 343—345), also, the well-known English Mycologist, Mr. Massee, has expressed similar views saying, "experience has proved that fungi undoubtedly are the cause of an enormous loss to cultivators of plants, either as primary or secondary agents, and as the injury caused by the fungus is much more obvious than that produced by the primary cause, it is usually concluded that the injury is entirely due to the fungus, whereas in reality, but for the road being made clear by the primary agent, the fungus, which completes the work of destruction, could not have gained a foothold. For the above reasons I am led to consider that attention to fungi alone is but a poor equipment for a post as Plant Pathologist, and will not lead to a reduction of the losses caused indirectly by fungi, which can never be exterminated."

No one who, like the present writer, owes his botanical training to the inspiring teaching of the late H. Marshall Ward is likely unnecessarily to minimize the importance of fungi. An experience extending over more than 22 years' service in the forests of India, however, has convinced me that œcological factors are of great importance in this question of plant diseases and urgently require detailed study. I have consistently urged this view, for many years, see *Ind. For. Mem. Bot.*, Vol. I, pp. 31, 32 (1911), *Ind For. Rec.*, Vol. V, 4, Part I pp. 38, 39 (1914), *Journ. As. Soc., Beng.*, Vol. XIV, 1918, No. 6, p 165, and *Indian Forester*, 1919, pp. 137, 138, and feel strongly that if we are to make real progress in controlling the diseases of our forest plants, we must develop and expand the

study of œcology, or as it is sometimes termed *field physiology*, and must regard plant diseases as complex problems frequently requiring for their complete solution the combined efforts of a number of experts, such as œcologists, mycologists and biological chemists rather than simple matters which only require for their satisfactory treatment the appointment of a mycologist, glorified possibly by the official title of Plant Pathologist.

In connection with the above remarks, the article on Charles *Ogilvie Farquharson* given below which is reproduced from the *Kew Bulletin*, 1918, p. 353, is of special interest.

R. S. HOLE,
Forest Botanist.

1*st June* 1919.

CHARLES OGILVIE FARQUHARSON AND HIS WORK IN WEST AFRICA.

It is with the deepest regret that his friends at Kew have learnt that the name of Mr. C. O. Farquharson, Mycologist, Southern Nigeria, whose appointment was recorded in *Kew Bulletin*, 1911, p. 377, occurs in the list of passengers missing as the result of the loss at sea, through collision of the homeward bound ss. "Burutu" on the night of 3rd October.

The keen enthusiasm brought to bear by Mr. Farquharson on his work, the sound judgment with which he confronted its problems, and the excellence of the results he had already achieved, afforded those interested in the future of West African Agriculture reason to expect for him a useful and distinguished career. We regret the tragic frustration of these hopes and lament the loss of a highly gifted and singularly attractive personality.

The following letter to the Assistant Director, dated 23rd September, and received at Kew on 15th October, was sent by the mail following the ill-fated vessel on which Mr. Farquharson sailed. The letter shows that he had a strong foreboding that his voyage home might end in disaster, and this is also indicated by its despatch by a later mail.

The letter is unlike any of the other letters sent by Mr. Farquharson from time to time to Kew, and is a remarkably graphic epitome of his life work in Nigeria. The nature of the work, the methods by which he sought to solve the many difficult problems, and the kind of education that his experience had led him to believe best for such work are all fully discussed. The views expressed apply to tropical plant pathology generally and are so worthy of consideration that the letter is published almost in its entirety. It is conceivable that but for his presentiment Mr. Farquharson would not in a single letter have embodied so fully his results and views.

AGRICULTURAL DEPARTMENT,
IBADAN, NIGERIA:
23*rd August* 1918.

DEAR MR. HILL,

Kew hears so seldom from me that I suppose it has by this time "written me off" a bad example of ingratitude and possibly as a failure. I am writing now because I am ordered home by the next boat, which sails about the beginning of next month. This will be posted by the following boat and will tell you what I have been doing, in case the Boche prevents me telling you what news I have in person. I hope to get home all right and see Kew, but one never knows. At the end of this month I shall have completed 23 months' residence, and it will be bad luck to get done in on the way home. However I want to get home for some things, and one must take the risk.

I may say that you have not heard of me mycologically because, except for rare and brief intervals, I have not been mycologist this whole tour. I have been a Curator, the Curator in charge of the field labour here and at Agege. My scanty daylight leisure I have not devoted to mycology, because Ibadan, or our part of it, is mycologically arid. I do not suppose you wish to be deluged with fungi imperfecti, Phomas, Cladosporiums, and such like. There are no others. So effectively cleared is our place that I rarely see a Mycetozoon. I did them up before the clearance was complete. Under the inspiration of my former

colleague, Dr. Lamborn, and encouraged by Professor Poulton, I have done little bits of entomology in my leisure, and perhaps know as much about the ways of getting at insect life-histories and noting their relations to their environments as any other mycologist in the field and may be a little more. With some knowledge of handling labour gained in 20 odd months' gang driving of some two hundred men, my education, I think, I can consider fairly wide, and in West African conditions, fairly useful.

Forgive this preliminary blast on my own particular trumpet — it is not intended to be a world resounding affair, but you may not be inclined to agree with some of my views later on and I am merely putting in a varied experience to disarm criticism as far as possible. I ought to add that George Massee's economic mycological outlook has influenced most things I have done, perhaps not published, but in the intimate expression of his views that he used to give at Kew. Again and again I have wished he were alive Kew wasn't the same place to me last time I was home.

My experience here, especially being in a position in which I was more or less responsible for getting up crops or giving a plausible reason for failure, has convinced me that every mycologist ought to be deprived of his microscope (and perhaps even of his pocket lens) for at least the first tour of his service, and perhaps for two years, and compelled to raise *normal* crops with no artificial aids of any sort. If possible, also, he should be compelled to study a really representative half dozen drainage problems and see them solved by experts. He would greatly benefit by having to dig a few drains himself. I do not pretend to be an expert, but for the first two months of this tour I did dig drains, bits of them myself, and supervised the digging of an open system, three feet and even over) deep. I had to do this because I diagnosed asphyxiation to account for defoliation and die-back on some of our cocoa here. Several nights I was so dead tired by 7-30 that I had to turn in without dinner. I had a very bad leave last time, and came back here feeling anything but well. But I saw the water pouring out of a clay subsoil, as each spadeful of soil came out, and in due course I saw the cocoa trees shoot

out leaf-buds everywhere, and that was something. When I read descriptions of "wither-tip" of some crop with elaborate cultural data of some obscure *Phomopsis* or other idiotic fungus, I blush for the quack who wrote it. I know there are other causes of die-back in cocoa and other trees that lack drainage. I have had such problems, but I am convinced that all of them can and must be solved without the aid of 1-12th in. objectives and Bordeaux mixture.

While I am on the subject of mycological quacks, let me tell you that to my mind the most outrageous are the entomogenous fungus "boosters." Massee shattered my faith in them. I had the luck to be in the Jodrell Laboratory when such a fungus came from the States, called *Aegirita Webberi*, named, I think, by Fawcett (California). "Aegirita" Webberi was the haustoria (moniliform clusters of cells) of a Peri-sporiaceous fungus (a sooty mould) which had grown on the secretions of the coccid it was said to kill. I regard the E. F. B.'s aforesaid as quacks, because so far I have met with none who attempted to find out when a coccid or any other insect dies a natural death, or conversely proves insects to be immortal, apart from those carnivorous fungi. Mycologists are not the only people led astray by insects. I know a medical officer out here whose bonnet harbours an insect, not a bee, but the species of *Chrysops* which is the intermediate host of a *Filaria* (*loa*, I think). It doesn't occur here but does in Sapele in particular. The medical officer came here a year or two ago, early in the rains (the spring). Seeing our nice fields of young maize, he asked, almost with a shudder, whether we got much trouble from red fly (*Chrysops*). I said it didn't occur at all, and he refused to believe me. I asked him why it ought to be here, and he told me he was certain its prevalence had a connection with young maize! He was so convinced that it was no use arguing that when the maize is young the dry season is over, the yams are young, the ground-nuts are young, and that, in fact, it was the spring. And the fact is, of course, there *are* no *Chrysops* here. Our mycological bug-slayers overlook the normal seasonal periodicity of insects, and it seems to me

that not a few have sprayed their fungus spores just when the insect was about to go anyhow. The seasonal periodicity of insects is extremely well marked here. One day, going from my office to my quarters, I probably see dozens of "painted Ladies" (*Pyrameis cardui*) Next day and for a few months they are not. Early in the rains for two or three days thousands of migrating Libytheine butterflies pass here flying southwards. The negro peasant knows that after that he may safely sow his cereal crops—maize, at any rate. Towards the end of the rains swarms of the same butterflies return northwards. One may conclude that the rains are over. Between the flights to and from the forest belt we never see them Unquestionably some of our insect pests are only pests when the agriculturist has failed. The agriculturist may not like to be told that. He doesn't object to be told to spray. There is a fine "act of God" feeling about it, so fine indeed that he doesn't even spray, but is satisfied with the belief that it *might* be done with success. The notorious West African cocoa "bark-sapper" (*Salbergella* sp.) in my experience is a pest on the careless agriculturist, a deserved visitation. A leading native grower here sent to the Department by one of our native instructors a collection of insect pests that were vexing him. They were bark-sappers. In the absence of our entomologist these things come my way (though I get no official credit). I sent the instructor to the plantation with a list of questions to answer as to the contour of the farm, soil and sub-soil, whether the pest was worst at the top of any slopes on the farm or at the bottom and if at the bottom whether the land was swampy. He came back, bringing trees (with roots) that he'd dug up. Before he said a word I knew from the stunted, gnarled tap-roots that the trees had grown on the most refractory laterite pan. He told me there was but 4 inch of soil above the laterite, and that the trees were on the top of a slope At the bottom, near water, on rich soil there wasn't a sapper to be seen I sent word to the owner that if he really wanted to grow cocoa on such a place he'd have to dig holes and deep, and fill them up with compost He would know himself, from his normal profit margin, whether the

expense would justify that method or whether it would be better to recognize that laterite was no soil for cocoa. When next I heard of him he had read my report in a meeting of the Agricultural Society of Ibadan and denounced my remedy (and me) as impracticable.

I noticed some time ago that ——— ——— after listing various non-cocoa host plants of the bark-sapper which ought not to be planted near cocoa plantations (including *Acalypha* hedges in his proscribed list), goes on to mention that though *Salbergella* is a parasite of *Acalypha*, which is a hedge at Aburi, yet the cocoa there appears never to suffer from the bug's attentions. I am strongly inclined to think the reason is that the Aburi cocoa is *cultivated* and is in a position to keep the sapper at a distance. Thrips of cocoa is unquestionably a sequela of misguided agriculture. I hope you will not think I am unduly critical when I say that the average———'s mental outlook is seriously distorted by a smattering of things entomological and mycological. They appear to me to think that because they know a bark-sapper or a root fungus and put down their names correctly that nothing more is to be said than that the trouble has been overcome by Bordeaux mixture or will probably respond to its application.

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If I had to map a course for a plant pathologist, I'd make a year's residence on a farm compulsory and make physiology, systematic and applied (the latter being essentially intensive agriculture and including soil physics and meteorology), the chief subject. I would bar microscopes till the last year of the training. Every spare hour should be in the field. Particularly futile I thought was a course of mycological lectures I once attended, futile because the average student there didn't know what it was to go into the field. Undoubtedly the Aberdeen student under Professor Trail stood a better chance of being able to interpret things as they appear in the field.

Field physiology, as opposed to laboratory physiology studied by means of beakers, tubes and all sorts of ingenious appliances, is a study that wants developing. Let me illustrate my meaning

from my own experience The optimum planting date for American cotton here is about the 17th of July. Every day planting is delayed after that, in a *normal* rainfall year, increases the risk of a short crop. The great limiting factor after that is the Harmattan which comes on about November or December after the rains have stopped but before any marked response to that—in the way of leaf fall has set in. Once the Harmattan sets in (it is more or less intense from the start) defoliation is rapid. That is followed by a meagre flush of new foliage, the leaves of which are greatly reduced in size. Flowers may still and do continue to appear, but the bolls are undersized, are often badly worm-infested, and when mature their cotton is rarely worth picking. Now you might think it would pay to plant a week or two or even a month earlier. Well, I tested the point by serial plantings, and found that June plantings or even more abnormally early are hopeless; the plants become the prey of the anthracnose fungus, Fusariums, physiological "red rusts," and dear knows what else. By the end of July they are the most stunted, miserable, flowerless, boll-less things you could imagine, blighted beyond recovery. I do not believe that spraying would be of the least good for the fungi (it would never pay on the bread and-cheese cut priced cottons we have to grow here), and even if the fungi were eliminated there would still be the other physiological troubles. The ground-nut here is another good instance. Ground-nuts may be planted here up to the end of April (the rains begin with the tornadoes about the end of March or even earlier), or if the rains are late, into May. They will grow magnificent plants of a diameter of six or eight feet if not crowded, and will mature about mid-July or August. Let us say that up to the time when the vine has stopped growing and is on the turn it gets x in. of rain. We used to plant (up to 1914) about June or even later. Planting then, it is quite possible that the crop before the rains stop will get x in. of rain, at times more, at times less. But the bulk of the plants will be stunted, chlorotic, or mottled and yellow, and instead of spreading normally (I am not referring to normal erect-growing types) grow *erect*, the leaves are very much reduced in size, and hardly any nuts are formed.

When I came here in 1912 I never questioned the time of planting. I took it for granted as correct. I found myself up against this bunching and mottling, could neither find insects nor fungi, and the tubercles on the roots were apparently normal. The natives do not grow them much here, and, truth to tell, I didn't think of asking them about the crop. I couldn't get to Northern Nigeria, where I know the nuts *must* grow well, and had to make the best of it. I tried all sorts of ideas, but mainly kept my eyes open for a field clue. I got this indirectly when trying to solve a rather similar cotton (native) type problem. Up to 1914 our highest yield of ground-nuts as harvested amounted to just over 500 lbs. per acre, which would probably have weighed about 300 to 400 lbs. when dry (unshelled nuts). We had many worse than that, that wouldn't bear recording, down to 11 lbs. per acre! Now normally we get from 1,000 to 1,300 lbs of well-dried nuts per acre (equivalent to about a ton as harvested). With the aid of lime, I secured 1,700 lbs. once, but the liming had nothing to do with disease. In a ten-acre field one cannot see a "bunched" plant. The cotton disease that gave me the clue was solved in a different way. Up here "native" cottons are affected by a serious and incurable disease, of "physiological" origin. The plants get contorted. The leaves get covered with intumescences on the underside, and fresh in the most extraordinary way. Flowering is greatly reduced, and, of course, bolling. The Upland Cottons (American of our introduction) were never affected. I found the solution of that from sheer field observation. Native plants near the coast, where the humidity average is much higher, grow normally. The key to the problem lay in the fact that the Americans were *upland* cottons. Their hirsuteness is an upland character. The natives (*G. vitifolium* and *peruvianum* strains) are glabrous. It took two whole tours before these obvious facts sank into my brain, but I doubt if anybody else would have done any better. The remedy for the disease was to grow the right cotton in the right place. Unfortunately for the cotton spinners, cocoa has long since ousted cotton from the high humidity belt. It was only from noticing a few stray survivors

of bygone cultivation at Bonny that I tumbled to the cause of the trouble.

Before leaving the ground-nut, I may say that my theory to account for the facts is that it is not the leguminous portion of the ground-nut that suffers in the mid-rainy season planting, but the nodule organism that is "diseased" (perhaps from too low a soil temperature during the period immediately after it infects its host, or perhaps even before that it has become "involuted") or because the soil then being at its maximum wetness, the organism in the soil has become involuted. When it does infect the ground-nut it either reverts to its ancestral parasitism, or, being itself at least below par, while not becoming a parasite, is yet unable to fulfil all the terms of the partnership. I may, as I have said, meet a Boche torpedo on the way home. If so, I hope you'll get some one to test my hypothesis. Further, I feel sure that something might emerge from a study of clover sickness along these lines at home. Could you induce someone to carry out serial plantings of clover varieties, both in England and Scotland? In the north of Scotland at least the disease doesn't occur. There may be some factor inhibiting out-of-season germination, either planting custom or meteorological.

Now you will see what I mean by *field physiology*. I doubt if any of the problems I have mentioned could have been solved in a laboratory, or at any rate only with the utmost difficulty and good fortune. I do not suggest that the problems are solved in the ultimate sense, but at any rate I know the practical remedies, and that is a great deal.

As you know I did find a real fungus disease last year, *Bagnisiopsis Dioscoreæ* (see K. B., 1918, p. 199), not a very serious pest but quite noticeable and very striking indeed. And as you know, perhaps, we have been having a great time with cocoanut budrot. In regard to that disease, it seems to me that too much has been made of *Bacillus coli*, and the elementary fact has been lost sight of that dicotyledenous plants die back following asphyxiation of their roots for want of drainage or other adverse soil

factors. The first symptom is the death of the growing point of the main axis, if there is one, or of that and the side branches. Now, a palm has only got *one* to go on with, outside its fronds, and when that goes there is no hope of recovery. That growing point can "go" exactly as one or many of the growing points of a dicotyledonous tree may and for the same reasons. The essential remedy is proper cultivation, growing the palms in the proper place on a proper soil in the proper way, with plenty of light and air. People have been so obsessed with the maritime habitat legend that they fail to see that the palm does well there because there are few competitors and it can get abundance of light to seaward and plenty of breeze.

* * * * * *

I hold strong views on cocoa disease out here, and to my thinking the key to the whole problem was indicated in that book by the late Secretary for Native Affairs, when he reminded us that "the native has no State-consciousness." The pest of cocoa *is* the native. He doesn't "cultivate" cocoa. He exploits a "weed" that yields a product closely allied to cocoa I pointed this out to Government here The great blight of cocoa is the fact that the native can exploit it at 10*s*. and less per cwt. cost of production of dried cocoa, and for years has sold it at 40*s*. and 50*s*. and even more. The best thing that could happen to Gold Coast and Nigeria native planters would be for them to be brought to the verge of ruin so that they might have to eat bread by the sweat of their brows and not ride in flash motor-cars by the exploitation of a product of the intelligent and painstaking selection of other races which happen to grow well, up to a point, in their country. I told the Government here that cocoa grew like a weed, that in fact it *had* to grow like a weed in order to survive. I illustrated this by reminding them how difficult it is to keep a prize vegetable (raised by long and intelligent selection) up to the prize standard. If it is put on poor land, is untended and generally neglected, it will have to revert to "weed-dom" if it is to survive at all, and if it does it will be no sweet and tender vegetable, but a hard-bitten, fibrous, just edible weed. The only

remedy for West African cocoa is to let in European enterprise to 'freeze out" the native if he fail to mend his ways. Cameroons *cocoa is the same variety* (largely) as Gold Coast and Nigerian, The soils are about the same. The difference in price of their product arises from this fact solely that Cameroons cocoa was prepared by natives as *servants* under the supervision of white men who *had* a State-consciousness and valued their reputations. No amount of preaching will make the native improve. Adversity may force his hand, but he may simply revert to yams and cassava and trading wild stuff. I think he will. In fact people talk at length about the phenomenal progress of cocoa on the Gold Coast. I took it on myself (when acting D. of A.) to tell the Government that it would have been better for the cocoa had the rate of increased production (which isn't progress if the product is the worst that comes into the world's market) been very much slower. I personally believe that the Western Ethiopian is as likely to change his skin as mend his ways. The facts of anthropology and ethnology are against him.

Last month a very interesting disease of Para rubber came my way, from a plantation at Sapele. They sent two large cases containing pieces of rubber tree stems and roots. No details were sent at all. They simply asked what was wrong with them. I could see nothing on the stem except *Diplodia cacaoicola*, which is no parasite of rubber, any more than of cocoa. However, I noticed two small rootlets with knobs on them, about the size of a small hen's egg. I could see they weren't eelworm galls, but was inclined to think the roots were there by accident. One "gall" was not quite so decayed as the other, and in folds or depressions of it I noticed groups of hairs very similar to those of mite galls. Yet I couldn't believe that such things could be made by mites, and a section of the "gall" was not helpful. So I wired for more specimens of the galls, and got them – things like big lumpy potatoes, and some bigger, on *rubber roots* all right. This time came a letter, in which the manager said he also sent a small packet of a bush plant that seemed always to be growing near attacked trees, and wished to know if it had anything to do

with the trouble. I opened up this package and was for the moment stumped. I thought they had nothing to do with the case. Kirby was looking at them, and probably thought the same You will perhaps think I ought to have spotted them at once but I am ashamed to confess that though I had often seen the bush plant I had never collected or studied it; but a dim recollection of Professor Trail's class-room came to me in a flash, and I *knew* it was one of the *Balanophoraceæ*. I think it is *Thonningia sanguinea*. The Yorubas call it Ade-ile—the Crown of the Land, an unusually poetic and pretty fancy for these people. I remembered seeing it frequently in the bush at Agege, so, having to go down there to pay the labour, I looked them up and tried to follow out the roots of one to the bitter end. I take it that the tuberous parts are haustoria. The ordinary roots, which are densely clad with hairs (similar to those of the "galls"), are long things, extremely long for the size of the plants. Some I followed out for six feet or more and failed to find the ends of them. I had very little time, not enough in fact to trace them to where they joined the host, and had to leave instructions for a native overseer to look for the "tubers." Some labourers apparently had seen the Ade-ile in our rubber plantation there, and so got on to them. Now, in connection with most fungus attacks I have personally seen hundreds of trees dug up from 1912 onwards and never yet met any "tubers" on the roots. What was my surprise when the overseer sent me a perfectly astonishing tuberous mass on one of our rubber trees, quite twice the size of a big human head, and enfolding two quite large Para rubber roots. I am now not a little puzzled over this problem. Has Ade-ile always been there and been overlooked? (The tree on which it had fastened showed no ill effects, and it is not yet clear whether they do so at Sapele.) The plantation has a bad fungus history, and they also must have dug out lots of trees. I feel sure they would have made special records if they had found *Balanophora* Or has the parasite taken about ten years (from the time the plantation was laid out -ours dates from 1910) to overcome the resistance of the Para rubber tree?

With great regret I had to give a careful study of our stem (post tapping) disease of rubber at Agege the go-by. You may remember that I suggested that the longitudinal cracks on the tapped surfaces are external manifestations of internal "shakes" of the star variety. I saw enough last year, during brief visits to Agege to look after and pay labourers—not to mycologise, of course—to convince me that the touble is physical and perhaps also physiological, and not the sequel to parasitism of any sort. However, I know that it is at its worst at the height of the rains. Four cuts (in the half herring-bone style) were made, and by the end of the season four tracts of outer cortex had been removed each about 4 inches wide.

It was evident at the end of the season that the location of the lesions had a definite periodicity which corresponded, as I have said, to the time when the rains were at their height. It seems to me that the longitudinal "fissures" in the unremoved layer of the cortex are the result of outward pressure of the growing central cylinder on the portion of the cortex weakened by excision of the outer layer in tapping. The weather conditions may either be such that callus-formation or bark-renewal is inhibited, or at any rate on the weakened place cannot keep pace with the excessive rate of growth that presumably occurs at the height of the rains. At any rate I think that phenomenon may be regarded as a "shake" of the cortex whatever the predisposing cause. Fungus attack may follow, but is by no means an invariable consequence, and there is frequently a normal renewal as the dry season ensues. The healed surface in such cases is irregular and "lumpy" and will be difficult ever to tap again, but the important point is that there may be no fungus-attack phase which appears to me strongly to support my hypothesis. If I get knocked out by the Boche you will at any rate be able to suggest to some one to attack the problem on those lines

Now I must be closing. This letter will come by the mail following the one by which I sail. I hope to have the opportunity to tell you my theories in person and clear up what I have failed to express clearly. I am bringing some good *Balanophora* material,

but apart from that I have nothing this leave I must again thank Kew for all the help I've had and apologise for the meagre return.

Yours sincerely,
C. O. FARQUHARSON.

EXTRACTS.

THE FORESTRY BILL.

The following is republished from *Nature* of July 31st, 1919:—

"The Forestry Bill, which was brought up in the House of Lords early in the month, has now passed its third reading. The Bill is the first attempt at forestry legislation to be brought before Parliament since the question of afforesting some of the waste lands in the country was first mooted more than thirty years ago. During this period numerous Commissions and Parliamentary Committees were appointed to consider this matter, but no planting was undertaken as a result of their deliberations. It is the war, and the enormous demands for timber, especially the softwoods of the trade, entailed by it, which opened the eyes of the Government to the dangerous position in which Great Britain stood in the matter of timber supplies. The Government Bill now before the country is closely based on the recommendations made by the Forestry Sub-Committee appointed by the late Minister of Reconstruction. It proposes the appointment of a Forestry Authority of seven (reduced to five in the House of Lords) Commissioners and the afforestation of 1,750,000 acres in eighty years, a quarter of a million acres to be planted in the first ten years at a cost of £3,500,000. The total cost of the undertaking will certainly be far greater than the estimates laid before the House, these estimates being very nearly pre war figures. The Bill was introduced by the Earl of Crawford It was opposed by Viscount Haldane, whose chief arguments were the danger of erecting

an authority of the kind proposed, which would not be subordinate to any Minister; and possessed of funds drawn from the Consolidated Fund, and not, therefore, placed on the Estimates, and consequently far less open to effective criticism in Parliament. The main point brought about by Lord Haldane, the one really weak part of the Bill from the scientific point of view, is the inadequate manner in which provision is made for future educational and research work and for the representation on the Board of Commissioners of forestry experts possessed of a sound scientific training. In the matter of scientific training and knowledge the proposed Board of Commissioners is a purely amateur one. Unless means can be devised to set up a Board truly representative of what is required—a Board which shall include a strong representation of men provided with a sound scientific training and a wide practical knowledge of forestry conditions throughout the Empire—there is a grave danger that the objects the Bill seeks to achieve will be doomed to failure from the outset, with the resultant disappointment and waste of public funds."

The reference to the absence of practical and scientific experts or the Board of Commissioners and the lack of provision for educational and research work renders the criticism in the last sentence all the more forceful. The British forest authorities could well be guided by the example of the United States of America who organized a research branch almost simultaneously with the creation of an effective forestry department. In India we have been concerned with the creation of a forest estate and in the restoration of irregular or partly ruined forests. It has taken time to convince others of the need for scientific and economic research into the mass of problems which have arisen and will continue to arise, it is therefore hoped that the British forest authorities will not follow in our footsteps but will institute a forest research branch from the very outset. If, as is stated, the Board lacks experts possessed of a sound scientific training the advantages of the creation of an authority independent of any Minister of the Crown will have been entirely frustrated and we must share in the doubts as to ultimate results.

SOME ENZYMES OF THE LEAF OF *LANTANA CAMARA*.

The *Journal of the Indian Institute of Science*, Vol. 2 Part XIII, contains an interesting note on the above.

This investigation was taken up with a view to find out some definite use for this noxious weed which flourishes in almost all parts of this country. The report of Dalzell that an infusion of *Lantana pseudothea* (Syn *Lippia pseudothea*) is used in Brazil as a substitute for the suggested or possible use of this plant, and accordingly the enzymes present in the leaves of Lantana have been identified and compared with those present in tea leaves. An attempt has also been made to prepare from these leaves a suitable substitute for black tea.

The enzymes present have been identified as—

(i) *Oxidase.* Its activity is perceptible in 3 hours and ends in 39 hours. It gives an intense blue colour with guaicum tincture. More enzymes are present in the ti› leaves than in the more mature leaves.

(ii) *Catalase.* It is soluble in common salt solution and is similar to B. catalase of Dr Loew.

(iii) *Amylase.* It persists even after the fermentation process is over.

(iv) *Invertase.*

(v) *Lipase.* Not ordinarily met with in the leaves of plants.

(vi) *Tanase.* Its absence is not conclusively proved.

(vii) An enzyme which breaks up the glucocides into glucose.

This is perhaps developed during the process of rolling when the cell walls are ruptured.

From the above it is evident that some of the enzymes are similar in character to those present in tea leaves.

Attempts were also made to prepare a substitute for black tea by subjecting the leaves to a process of withering, rolling fermentation and drying. The best results were obtained by withering the leaves for 5 hours at 75°—77° F., rolling them for ¾ hour and then drying for ½ hour at 75° C. after allowing them to ferment for 18 hours The appearance of the leaves after the above process was black with a faint yellow tinge. The colour of an infusion

prepared from these leaves resembled the colour of an infusion similarly prepared from Lipton's yellow label tea and the flavour was not unpleasant, the greater part of the unpleasant essential oil having escaped during the process of fermentation and drying. With more detailed investigation about the ideal condition of fermentation, drying etc, it will very likely be possible to prepare a suitable substitute for black tea at an exceedingly cheap cost.

[The above is of interest to forest officers who are concerned with the problem of removing this noxious weed. It does not seem probable that an industry will arise so long as tea cultivation is capable of extension. If, however, a condition arose in which the tea industry could no longer meet the demand it would perhaps be possible to develop a use for Lantana in the direction above described. Lantana flourishes under conditions which are quite unfavourable to tea.—HON ED.]

DISTRICT FOREST EXHIBITIONS.

An exhibition of forest products was arranged by the South Garhwal Division of the United Provinces on the occasion of a Darbar held by the Commissioner at Srinagar (Garhwal) in March last. The number of visitors from all parts of the district is roughly estimated at 15,000.

There were 176 exhibits of various forest products shown under the following heads.—

Agricultural implements	13
Wooden utensils	4
Furniture (locally made)	3
Miscellaneous wood articles	3
Ringal articles	20
Tans and dyes	3
Medicines and drugs	36
Fish poisons	4
Oil-seeds	7
Gums	6
Chir products	8
Fibres and flosses	28
Famine foods	16
Gunpowder charcoal	2
Skins of carnivorous animals	6

Hill paper	...	...	...	4
Tooth-brushes	...	...	...	4
Miscellaneous products		..	...	9

Among the forest cottage industries, the processes of paper-making from *Daphne cannabina*, making of ringal articles and wooden utensils by local turners formed the most interesting feature of the exhibition.

The following notice was placed in the Forestry Section and other places in the exhibition both in English and in the Vernacular of the districts :—

" The extensive Chir forests of Garhwal if worked for turpentine, rosin, tar and pine needle oil will bring in at least another lac of rupees to the district, which will mean more comfort to the people in the way of communication by Railway and an increase in the number of cart-roads, schools and dispensaries, etc., etc. Hence fire-protection of the Chir forests is essential.'

To our knowledge, this is the first attempt at holding a district exhibition of forest products in the U. P.—an attempt which, though modest, cannot fail to be useful and we must congratulate Mr. Mathura Prasad Bhola, the D. F. O , upon the idea and its success.

Forest conservancy has recently been inaugurated in the inner hills of Garhwal and has been the cause of considerable anxiety and ill-feeling towards the Forest Department. The forests are of special value to the country, not only as a source of industrial enterprise and means of support to a population that already exceeds the agricultural possibilities of the country, but they represent the only known natural wealth of the locality. As the sources of the springs which supply the bulk of the water to the Ganges Canals these forests have a significance and value far beyond the interests of the local inhabitants. The exhibition therefore presented a means of propaganda work among the local inhabitants which should go far towards removing existing misgivings and misunderstandings and we draw the attention of Forest Officers and others interested in the forests of India to the importance of such exhibitions as a means of educating the people and popularising and developing local industries.

EDITORIAL NOTES.

In a leading article *Nature* of 7th August deals at length with the Forestry Bill which is about to become law in the United Kingdom. This article will well repay perusal as it elaborates the points already brought forward in the note reproduced in this journal.

American Forestry for July is an unusually interesting number. It continues an interesting series of illustrated articles on the work of the American Forestry corps in France. The most interesting contribution is, however, H. Maxwell's account of "Wood used in the Cooperage Industry." The large and varied assortment of American timbers, including saw-mill refuse, used in the cooperage trade indicates that Indian timbers are likely to prove equally adaptable for this purpose. The war has undoubtedly changed conditions as regards the manufacture of barrels in this country for a variety of purposes. We have long been aware that the chir pine (*P. longifolia*) yields a good barrel both for 'tight' and 'slack casks and when Indian engineers awake to the fact that locally manufactured cement can be packed in casks a considerable impetus should be given to the slack barrel grade. Oilseeds, copra, etc., were formerly exported to Europe, but the oil is now largely manufactured in India and there appears to be scope for the development of the tight cask industry. We are not aware that, outside Southern India, this industry has as yet made much progress The United Provinces Government has made a start at the Wood-Working Institute at Bareilly and we have seen excellent samples of tight barrels made by the cooperage class. There is danger that unless the subject is taken up and pushed vigorously steel receptacles will supplant the wooden barrel in all commercial undertakings.

The recommendations of the Board of Forestry regarding the future expansion and scope of the Forest Research Institute at Dehra have borne fruit. A scheme has been prepared for the transfer of the Institute to a new site of about a thousand acres,

at a distance of some four miles from Dehra. On this area it is proposed to erect a much enlarged Institute building, workshops, laboratories, students' quarters, houses for the whole staff and at the same time provide ample room for expansion in the future. An *arboretum*, experimental and demonstration areas will occupy about half of the total area. Steps have already been taken to acquire a complete equipment in the shape of a creosoting plant, drying kilns, pulp plant, testing machines and fully equipped workshops, which are immediately to be erected. The whole scheme is estimated to cost thirty lakhs of rupees in capital outlay and with additions to the staff in all branches is being referred to the Secretary of State for sanction. Those who have studied the remarks of the Industrial Commission on the requirements of this country in the direction of forest research will welcome this announcement. Our only comment is that the proposed expansion comes rather late in the day and the staff will have its work cut out to keep pace with industrial requirements.

REVIEWS.

REPORT ON THE FORESTS OF BRITISH COLUMUBIA.

We have received a report issued by the Commission of Conversation, Canada, under the title of "Forests of British Columbia." The authors are H. N. Whitford, Ph. D., and Roland D. Craig, F. E.

It will be remembered that at the last meeting of the Board of Forestry Mr. Raitt read a paper urging the necessity of our taking in hand an inventory of the forest resources of this country and of revising our methods of dealing with the commercial world. The work before us, running to over four hundred pages, could well be taken as a guide for the above investigations if ever they are taken up. There is no room for doubt that the Dominion of Canada, although it may have made a late start in organizing a department of Forestry and conserving its forest resources, is now making rapid headway. That there is leeway to make up may be realised from the fact that in British Columbia, the timber on

100,000 square miles, or two-thirds of the land once forested, has been totally destroyed by fire, and on over half of the remaining 55,855 square miles the timber has been seriously damaged. The volume of timber destroyed to date by fire in this province alone is estimated as equal to the existing total growing stock of the entire Dominion.

The geographical, physiographic, climatic and soil relations to the distribution of the forest products are analysed in the first three chapters. The fourth chapter deals with land tenure and traces the development of the various forms of disposal. These are complicated by the existence of provincial as well as dominion forests within British Columbia. About three-quarters of the alienated timber land is held under timber licenses, which originally were of short duration, even as short as one year, and in order to ensure security of tenure and thereby attract capital were extended in 1910 to a term of 21 years. Perpetual licenses renewable from year to year were then introduced allowing, on payment of 20 dollars, continuation of operations so long as there remained "merchantable timber in sufficient quantity to make it commercially valuable." A rental on the land as well as a royalty on the output are leviable. After 1920 the royalties are to be readjusted every five years on the basis of the average wholesale price of lumber, the Government taking a share of the surplus, if any, over certain figure already assessed as allowing a reasonable profit to the lumberman. The Government share in the increase for the various periods is as follows: –

1020—24, 25 per cent.; 1925—29, 30 per cent.; 1930—34, 30 per cent.; 1935—39, 35 per cent.; 1945—49, 40 per cent.; 1950—54, 40 per cent. We quote as follows:—

"This schedule of royalties recognizes three important principles: first, that the public is entitled to a share in the unearned increment due to the increasing timber values; second, that it is unwise to impose a charge which is liable to force the exploitation of the forest resources beyond the market requirements; and third, that security of title is essential in the carrying on of large business enterprises, such as are necessary in the lumber industry of to-day."

In India the minds of forest officers have been troubled with the introduction of clauses into leases which would secure to the tax-payer a share of the enhanced value of our timber and other forest products. The above is suggestive of a line for future action although it cannot be applied to new industries which have not established a representative wholesale price for their products. The wholesale values of lumber throughout America are well known and can be easily ascertained. Similarly teak has an established sale value which is capable of ascertainment in the world's markets so that the principles above enumerated would perhaps be applicable in the case of leases for teak timber and there may be other timbers in the same category.

The forest resources of the province of British Columbia are given according to species and in the minutest detail, with excellent maps of main regions which are usually sub-divided according to the principal lines of extraction such as lakes, rivers and railways. The climate and natural features are described and full particulars given of existing industrial undertakings. To the industrialist who is in search of means of utilizing his capital the book fulfils every possible requirement and its perusal at once gives prominence to many valuable ideas which we can adopt to our own needs. Allusion has been made to certain maps but the two loose maps in a cover-pocket, which illustrate the main types of forest and the distribution of the principal trees are educative works. Thirty-eight excellent photographic plates serve to convey an idea of the country, its forests and principal timber industries. The object of the publication is essentially to maintain or awaken industrial interests and the three years said to have been occupied in its compilation should be time well spent. The following extract is significant:—

"*There is, in India, a most profitable market for Douglas Fir railway ties so treated that they will withstand the attacks of white-ants. The Indian Government is anxious to co-operate in such necessary investigations as will enable it to procure its supplies in Canada.*"

Judging from the point of view of preparedness British Columbia comes on the field with everything in its favour Shall we continue to lag behind because our problems are too big to tackle?

NOTES ON FOREST POLICY AND FOREST MANAGEMENT.

We have also received a booklet of 16 pages titled "Notes on Forest Policy and Forest Management," by F. A. Lodge, C.I.E., I.-G., Forests, Hyderabad (Deccan). In the preface the author writes:

"This note has been written in the hope of removing some of the false ideas regarding a much maligned Department, and spreading some little knowledge of the necessity for its existence and the objects it seeks to attain."

After a careful perusal, we cordially invite the attention of all those who are interested in forest matters to study the publication As a means of disseminating knowledge of the aims and objects of forestry among our politicians Mr. Lodge's notes could well be circulated by all local Governments and reproduced in such publications as are contemplated by Government with a view to remove and counteract mischievous and misleading ideas.

The "notes" are issued by the Bulletin Press, Secunderabad, at the price of one rupee but considerable reductions can be obtained on large orders.

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THE "SPIKE DISEASE" OF PEACH TREES: AN EXAMPLE OF UNBALANCED SAP-CIRCULATION.

BY ALBERT HOWARD, C.I.E., M.A., IMPERIAL ECONOMIC BOTANIST, AND
G. L. C. HOWARD, M.A., SECOND IMPERIAL ECONOMIC BOTANIST.

The characteristics of the spike disease of the sandalwood in Mysore have been the subject of numerous contributions to the pages of the *Indian Forester*. During the last two years, interest in this matter has been reawakened in consequence of the fact that Coleman's theory of the ultra-microscopic parasitic origin of the trouble has been challenged by Hole who has brought forward a good deal of evidence in support of his views. Hole considers that spike is the result of prolonged unbalanced sap-circulation brought about by various adverse factors and that the parasitic origin of the disease has not been established.

The present paper deals with the description of a pathological condition of the peach tree which closely resembles the spike of sandalwood and which is undoubtedly caused by prolonged unbalanced sap-circulation. This condition can be conveniently described as the "spike disease" of the peach.

When the peach is budded on the almond at Quetta, either by the Indian method of ring budding or by means of side buds, a certain number of abnormal plants result. The first cases were noticed in 1915 in the case of an early peach side-budded on the almond in August 1912 Six of the resulting plants were planted out and were found to grow with great slowness and to produce much paler and more crinkled foliage than that usually met with in the peach. Three of these trees have already died and at the time of writing (September 1919) only three out of the original six remain, the average height of which is four feet compared with the thirteen feet of normal trees in the same plot. Similar plants have been noticed every year in small numbers in the nurseries where young almond seedlings have been ring-budded with the peach and it has been the practice at Quetta to destroy them every September. During the present year (1919) the opportunity was taken of investigating the cause of the trouble.

These abnormal peaches are easily distinguished by the foliage. The leaves are paler in colour and smaller than the normal. They are more or less curled and hang close to the stem (Plate 31, Fig. 1) They are also thicker to the feel, cracking across when bent like ripe tobacco leaves. Where the spiked condition is most strongly developed, the leaves have very little green colour left and turn yellow, at the same time developing a reddish colouration (probably anthocyan) all over. Soon after the red colour develops, the leaves fall. Affected plants are to be seen in September quite bare of foliage while normal specimens are still in active growth. The reduction in the size of the leaf varies. Ordinary peach leaves measure about 16 by 3·6 cm. When the abnormality can be clearly distinguished, the leaves are about 12 × 2·6 cm. In extreme cases, the average is 5·3 × 1·2 cm., that is, about one-third the ordinary size.

In addition to the leaves, differences are to be seen in the stems and roots. The twigs of affected plants are slightly thickened at the end, the internodes are often contracted and the buds swell and mature much before the usual time. In such

Fig. 1. Normal (left) and spiked (right) peaches budded on almond.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. The root system of normal (left) and spiked (centre) peaches budded on almond. On the right, the roots of an unbudded almond seedling.

plants, the wood ripens at least two months before the normal. Below the junction of stock and scion, the bark often looks starved while the root system, compared with that of healthy plants, is very poorly developed (Plate 31, Fig. 2). At the junction of stock and scion, there is always some local thickening which increases considerably as the condition becomes more marked.

All gradations occur between an extreme condition and a slight amount of spike. Badly affected trees die during the second and third years while those which are only slightly affected live for at least seven years and bear fruit. Some of these slightly affected trees were planted out in 1913 but have not recovered in the interval. On the contrary, they are now becoming unthrifty, branches are beginning to die and they are not expected to survive for more than one or two years. Side by side, normally developed peaches, budded on the almond, are thriving and show no signs of failure.

Microscopic examination of affected plants at all stages has yielded interesting results. The leaves, when tested by Sachs iodine method, show the presence of starch greatly in excess of the normal particularly in the veins. Sections confirm this and show the cells of the mesophyll crammed with starch grains exactly as in the case of the spike disease of sandalwood. Starch is also abundant in the vascular bundles and particularly in the sheaths which surround them. Normal leaves of the peach and almond, on the other hand, show only the usual amounts of starch. Sections of spiked twigs and branches show an enormous accumulation of starch in the pith, in the medullary rays in the wood and bast parenchyma and there is a sharp line of demarcation, as regards starch deposition, at the junction of the stock and scion. While starch is abundant in the phlœm and xylem of the scion (peach) there is practically none to be found in the stock (almond). Where the abnormal condition is less marked, there is again an enormous accumulation of starch in the bast and wood of the scion but, in these cases, a certain amount of deposition also takes place in the stock but this is not very great. In normally grown peaches ring-budded on the almond, the

differences in the amount of starch deposited in the tissues of the scion and in those of the stock are much less. Even in these cases, however, there is more starch in the phlœm of the scion than in that of the stock, a circumstance which probably helps to explain why the peach almond combination is so fruitful at Quetta. In normal cases, however, the junction between the stock and scion is a sharp one and there is very little local thickening at the point of union.

As in the case of the sandalwood, the composition of the leaves of healthy and spiked plants show marked differences. Leaves from two spiked and two normal plants were collected at the end of August and were dried separately in the sun. The dried samples were then sealed up and were afterwards analysed by Mr. Jatindra Nath Sen, M.A., Supernumerary Agricultural Chemist, with the following results :—

TABLE I.—ANALYSES OF PEACH LEAVES—RESULTS CALCULATED ON WATER FREE MATERIAL.

Description.	N	Loss on ign.	Soluble mineral matter.	Ms Res.	Fe_2O_3	P_2O_5	CaO	MgO.	K_2O	Starch.
Spiked peach leaves.	1·76	94·[illegible]2	5·62	0·36	0·07	0·[illegible]5	0·94	0·92	0·14	5·15
Normal peach leaves.	3·6[illegible]	90·85	8·87	0·28	0·17	0·51	1·64	0·83	0·64	2·02
Spiked peach leaves.	2·06	91·91	7·75	0·34	0·09	0·26	1·62	1·15	0·21	4·36
Normal peach leaves.	3·2[illegible]	90·50	9·10	0·40	0·07	0·51	1·93	1·09	0·44	2·83

The results show there is less nitrogen, less ash phosphorus lime and potash and more starch in the abnormal than in the normal leaves. The figures closely follow those obtained by Coleman in the case of the sandalwood in Mysore. The most obvious explanation of these differences is that the leaves of spiked plants are unable to obtain from the soil a sufficient amount of crude sap and are also suffering from an undue accumulation of reserve carbohydrate.

The results suggest that the cause of the spiked condition is to be found in the junction between the stock and scion. This was confirmed by investigating affected plants from the earliest stages and by comparing them with normal plants. Spiked plants were found to result from a delayed junction between the ring-bud of the peach and the almond seedling. If the operation of budding is properly done, the peach bark ring is pushed home and comes in contact all round with the living bark of the almond. The two barks join all round in about a fortnight after budding, and the peach bud throws out a new branch very quickly. There is practically no formation of callus tissue between the two kinds of bark and the junction is a sharp one. Such plants develop normally. Sometimes, however, the peach bud is not pushed home and a more or less complete space, about 2 to 3 millimetres wide, is left between the ring bud and the living bark of the almond. In these cases, the bud takes very slowly, the growth of the new peach branch is delayed and the two barks do not join till a callus tissue has been produced by the almond and by the peach from both sides of the vacant space. This often takes as much as six weeks to form. Such plants always become spiked as the callus tissue is too wide for normal translocation to take place. As a result, the junction is interrupted, the translocation of elaborated food material from the leaves to the roots by way of the phlœm is greatly restricted, starch is in consequence deposited in the leaves and twigs while the root system is starved. This in turn leads to a diminished supply of crude sap to the leaves. The final result is a pathological condition in which all the morphological and anatomical peculiarities of the so-called spike disease of sandalwood are exactly reproduced. The cause of the trouble is obviously the prolonged unbalanced sap-circulation resulting from an imperfect junction of the stock and scion. The greater the interruption at the point of union, the more the spiked condition is developed.

A perusal of the literature on the spike disease of sandalwood has suggested two things. The problem would appear to be considerably clarified if the sandal is looked upon as root-grafted

on to its hosts by means of the haustoria and if the association is regarded as symbiotic rather than parasitic. The anatomical facts clearly show that sandal obtains its crude sap from its hosts. The structural complexity of the haustoria and the fact that they often contain starch suggests that the sandal also feeds the roots of the host at certain times with elaborated food material. When adverse factors, as suggested by Hole, slowly destroy the haustoria, this symbosis would be gradually interrupted, the supply of crude sap to the sandal leaves would fall off in amount and the circulation of elaborated food material from the sandal leaves to the roots of the hosts could not proceed in the normal fashion. The result would be slow starvation as in the peach and the development of the spiked condition. This point of view would bring together all the known facts with regard to the spike of sandal, of peach and of wild plants like *Zizyphus Œnoplia* and *Stachytarpheta indica*. The cause of the trouble should, therefore, be searched for in the factors which produce unbalanced sap-circulation in all these cases and not, as suggested by Coleman, in the direction of an ultra-microscopic parasite. There appear to be some factor or factors in South India which, under certain circumstances, interfere very gradually with the action of the haustoria of sandal and with the root system of plants like *Zizyphus Œnoplia* and *Stachytarpheta indica*.

Besides their bearing on the cause of the spike disease of sandalwood, these observations are of interest in connection with the proof of the transmission of disease by means of grafting and budding. It is often stated that if mysterious diseases, the precise origin of which has not been discovered, can be propagated by a bud or a graft, the result is proof positive that we are dealing with a parasitic organism of some kind. The greatest caution, however, is necessary in drawing conclusions of this kind. Not only may the results be affected by poor junctions and the consequent production of callus tissue as in the "spike disease" of the peach but the mutilation of the stock itself introduces important complications. The partial or complete cutting back of a vigorously growing seedling almond leads to extensive

destruction of the feeding roots. If this is done in May when the stock is too young, death is a frequent result. In other cases, partial starvation is common and the new shoots produced on the stock below the bud as well as the new peach branch itself are weak and chlorotic. May not spike in sandal be produced by the mutilation of young trees at certain times and may this not be found to be the real explanation of Coleman's grafting results? We can easily produce wilt in indigo, a somewhat similar condition to spike, by cutting back healthy plants at seasons of the year when root regeneration is very difficult.

NOTE ON CANADIAN LUMBERING METHODS IN FRANCE.

BY TEMPY CAPTAIN R. MCLEAN, R.E.

The note below was originally written in France while I was attached to the Canadian Forestry Corps. It attempts only to sketch in broad lines the methods and plant used for forest exploitation by the Canadian Forestry Corps and to consider how somewhat similar methods might be applied in India.

It is taken as axiomatic that India's timber resources must be exploited to fuller advantage than in the past; that exploitation and reafforestation must go hand in hand; and that to take full value of the resources, especially of the Himalayas, some form of antiseptic treatment must be adopted for the soft woods.

2. The Canadian and American timber trade is probably the most up-to-date in the world in its methods. Labour saving is studied in every part of the organisation and equipment. The plant used latterly in France embodied the results of much experience in England and France and was thoroughly efficient while the Forestry Corps was officered by men who were experts in the trade and who, as far as possible, ran the forests on business lines

3. Estimates of cost of timber are not available nor would prices, based on a war undertaking of this nature, be of any value for an estimate for peace-time conditions. Moreover, the installations were temporary and would be modified and improved for a permanent mill. But for a sleeper and scantling mill for

experimental purposes in India a very similar plant might be expected to give good results.

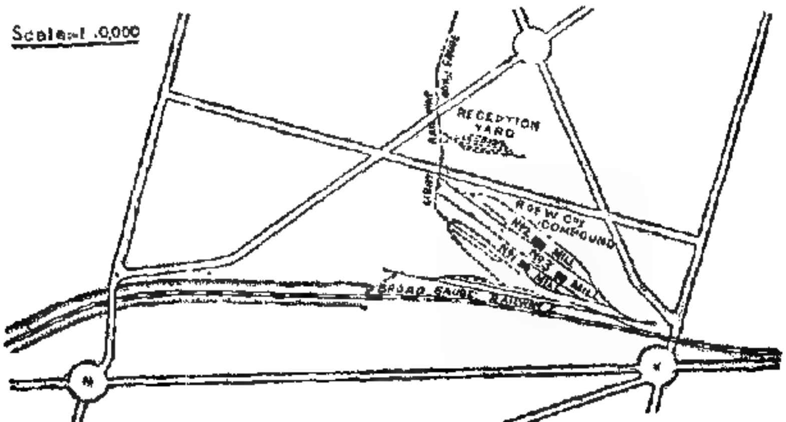
4. This description has reference to the Forest of Senonches in the Department of *Eure et Loire.* $1\frac{1}{8}$ *million cubic feet* of timber were allotted to the British Army. After marking for felling it was found that $2\frac{1}{2}$ million cubic feet, spread over an area of six miles by one and a half miles, were actually available.

It was decided then to lay down three mills, two main and one resaw. The main mills had an output each for an 8 hour shift of 20* to 22,000 feet board measure of mixed lumber or 34 to 35,000 feet board measure of sleeper (850 sleepers B.G. per shift) while the hand resaw had one machine for breaking up off cuts into scantlings.

Logs ran from 18" to 36" average diameter in mixed oak and beech.

5. The mill site was close to a broad gauge line where special holding and loading sidings were laid in. Carriage of logs from "bush" to mills was by light railway of 60 c.m. gauge (1' 11$\frac{5}{8}$") picking up close to the felling points and delivering at saw bench level in the mills.

To save tedious description the layout of the mills is sketched below. The "dotted" lines show the 60 c.m. layout and



* All lumber measurements are reduced to feet board measure, *i.e.*, are stated in equivalents of planking 1" thick. For example a scantling 12" × 4" × 12' long has 48 feet board measure.

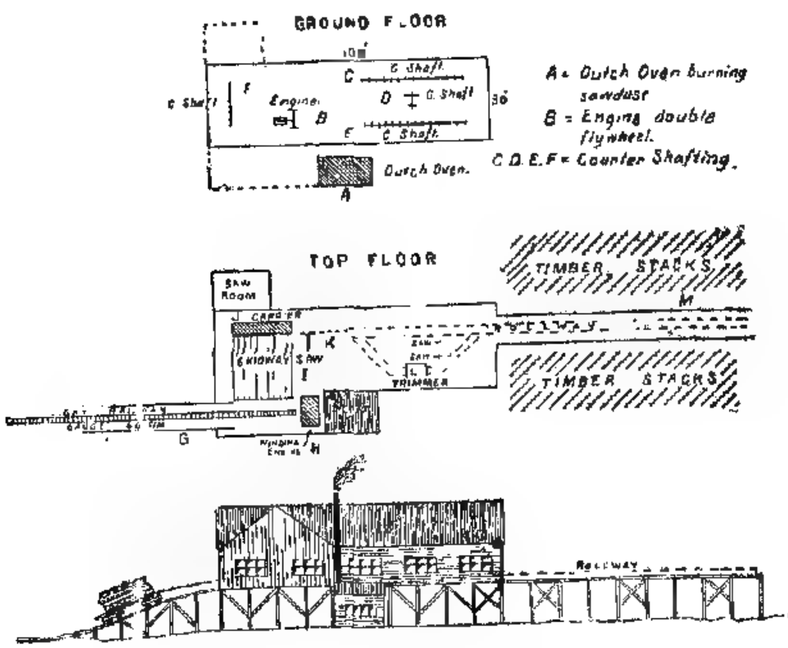
the comparatively extensive siding accommodation is explained by the need for enough holding lines at each mill for loading for a full shift with a further reserve in the event of a break-down in the bush despatches.

Numbers 1 and 2 were the main mills with 56 diameter circular saw, trimmer and subsidiary saws. No. 3 was the hand resaw.

Main mills were two-storeyed, 100′ × 30, of timber framing. By a ramp 125′ long, slope about 1 in 9, narrow gauge trucks, were hauled to the upper floor and delivered on skidways at saw level.

Power, drive and shafting and electric light plant were at ground level.

DIAGRAM OF MILL
(NOT TO SCALE)



Logs loaded on 60 cm. flat cars are hauled by winding engine (H) up ramp (G) rolled by hand across skidways (I) to carrier, (J) thence back and forward across the saw, (K) to brow, (M) either direct by Rollways or through trimmer (L).

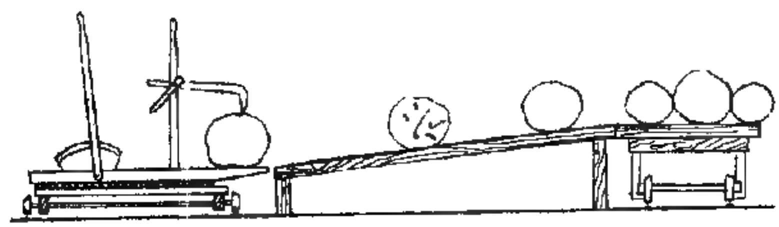
6. Details of plant—

(*a*) *Dutch oven* (Farrar colonial boiler).—A specially arranged sawdust burning boiler 12′ 6′ diameter, 5′ barrel, 75 per cent. of the sawdust produced is used as fuel and the arrangement for feed is so simple that one fireman can attend to two mills.

(*b*) *Main Engine.*—$12\frac{1}{4}''\times 16''$, two cylindered, medium stroke engine by Robey & Co., Lincoln, running at 145 revs. per minute. Flywheels are 7′ and 5′ diameter respectively.

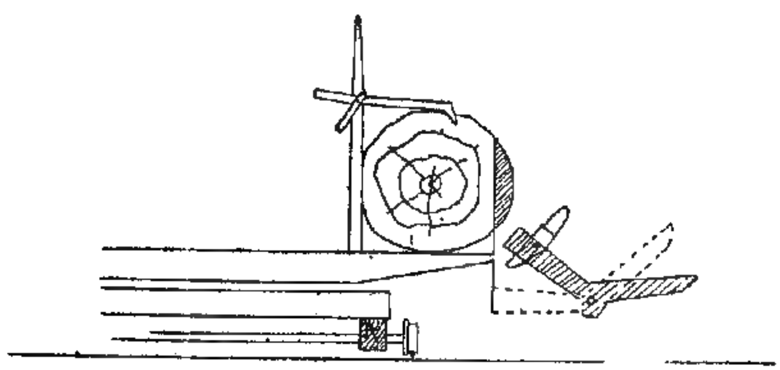
(*c*) *Carrier, Carrier drive and Nigger.*—

Carrier.—A four wheeled truck 14′ long running on rails of about 3′ 6′ gauge. The log is carried on the three arms of a frame-work, which is traversed laterally by a ratchet arm worked by the "Setter."



The traverse movement is recorded on the callibrator giving thus the thickness of each cut. The whole frame is mounted on a spring to return the frame to zero position when released.

Fixing dogs are provided on 3 pillars on the carrier frame.



Carrier drive.—Feed across saw is at the rate of 4″ cut per rev or 240′ per minute (700 to 750 r p m.). Drive forward and back is

by continuous wire rope through friction drive worked by the sawyer by lever.

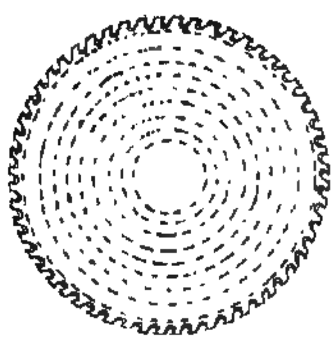
Nigger.—The "Nigger" is a wooden skid helping to turn the logs on the carrier. It is worked by the "sawyer" through a foot pedal

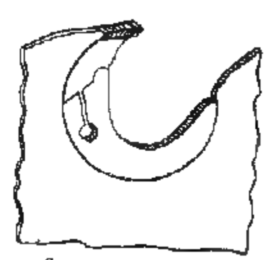
The shaded portion of the log is taken off in the first cut. The log is then turned partly by "cant hook" (see para. 10), the "nigger" at the same time being raised to catch and stop the cut surface as it turns over. By dropping the "nigger" the log slips into place resting this time on the cut face—ready for a second cut for squaring.

(*d*) *Circular Saw.*—56" diameter with 56 teeth running at 700 revs. per minute. Thickness 8 G. on rims and 9 G. at centre. Depth of tooth 1½". Maximum log capacity 36".

Teeth are removable, slipping into the saw framing by a spring. The main body of the saw therefore is seldom damaged by knots or dogs in the timber, while if teeth are broken, new teeth can be immediately put in. These saws have the great advantage that saw diameter and perimeter speed are constant and do not alter with wear. They are also cheap in use

Hammering of saws.—It will be recognised that a saw running at high speed in timber will develop different temperatures decreasing from the perimeter towards the centre. For true





Removable Teeth

running and cutting it is essential that when the saw has reached its maximum heat and expansion has taken place the induced stresses from temperature should be equal throughout.

Before use there a saw is "hammered" so that the outer fibres are in tension reducing to compression towards the centre of the saw—in other words a cold saw ready for use, if shaken by the perimeter, will "flop" in the centre.

To produce this condition the saw is divided into an equal number of radial sections and hammered at the points of each section as in sketch.

Special hammers and anvil are used for this work but the art lies not in the tools but the workman. Any man of reasonable intelligence could be taught the work

(*e*) *Trimmer and subsidiary saws.*—These require no special description.

(*f*) *Sawdust conveyor.* All sawdust is removed from saws by timber ducts with an endless chain fitted with slats. It is delivered at hoppers (*a*) to boiler and (*b*) to carts for removal and dumping. Where sawdust is burned in the boiler only about 25 per cent. has to be disposed of otherwise. In large operations with resinous timber this might be broken up by distillation into oils and tars.

PERSONNEL.

Sawyer.—It may be remarked at the outset that the efficiency of the mill depends on the "sawyer." He it is who estimates the timber in the log as it goes on to the carrier; who gives his orders by sign to the "Setter" for the cuts to be taken; who operates the carrier lever and the nigger. On his estimates depends the waste and lost cuts from each log. In Canada a good sawyer can earn from £500 to £600 a year.

Not every man will turn into a good sawyer and it takes, in any case, many years of apprenticeship to learn the trade.

Setter.—The "Setter" works the lateral movements of the carrier frame by ratchet across the saw face. His position is on the carrier, orders for the cuts to be taken being given by sign from the sawyer. All lateral movements of the carrier frame are registered on the callibrator. All the setter need do then is to remember the readings for the two dimensions of the squared log and set for each cut by addition for the thickness of cut and ⅛"

allowance for the saw. In time the work becomes largely mechanical.

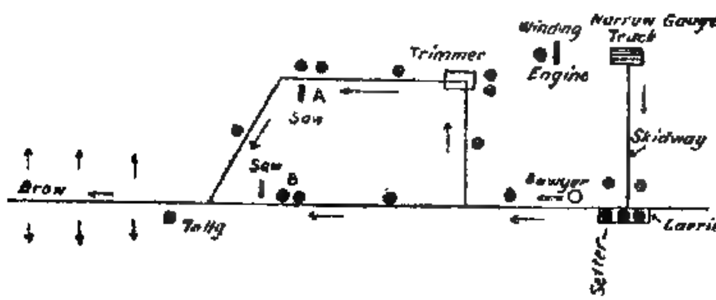
The other important technical personnel about the mill are :—

Edger men ... ... for the trimmer.

Filers ... . for the saws.

Their duties can be taught to an ordinarily intelligent technical workman by a good sawyer.

Arrangement of personnel in mill—



● Personnel who could be trained in India. ●—Specially skilled man who must be imported in the first instance.

● — *Personnel who could be trained in India.*

○ — *Specially skilled man who must be imported in the first instance.*

The diagram above shows the general movement of log through the mill and the personnel required to handle the timber. With the exception of the sawyer all personnel for the work could be trained locally.

In practice the work in the Senonches Mills was done in the main by German prisoners of war of no very great intelligence.

Millwright.—An officer of the rank of Lieutenant was in direct charge of the mills. In civil life his trade was a "Millwright" or what we should call a Mill Manager. Those I met had been at the trade since youth and were able to do anything about a mill, act as sawyer, setter, skidder, file or hammer a saw and set out and erect a mill. A man of this class would be essential in any installation.

BUSH.

8. Bush work is not complicated. The bulk of it can be performed by partly skilled labour. Granted reasonable physique a very short experience will turn out a decent "feller." What is

important is that the equipment should be, as far as possible, labour saving and the Bush work should be concentrated so as to reduce the number of saw filers and axe sharpeners to a minimum.

9 *General arrangements.* -Selected trees are marked, scaled and contents estimated. Felling then begins. Three men make a felling gang and have the following equipment :—

Axes	...	...	...	4
Two-handed saws (lance tooth)			...	2 or more.
Iron wedges	...	...	...	4
Hammer sledges, 8 lb.		. .	...	2

The tree is notched deeply on the fall side and shallow on the other. A two-handed saw lance toothed, said to be 2 to 3 hundred per cent. more efficient than a cross cut, and wedges complete the job.

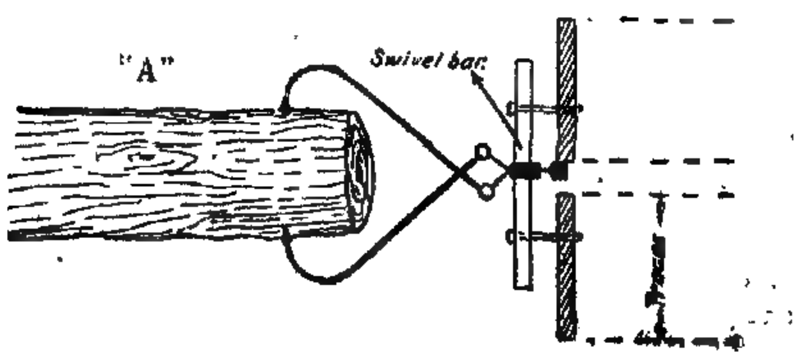
Branches are then lopped, the trunk scaled and cut up into logs.

Later, by unskilled labour, the branches are cut up into firewood and stacked or faggoted.

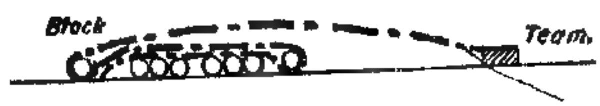
In Senonches, using prisoners of war labour, the average daily output per head was 13 logs. That is, a felling gang felled, lopped and cut up 7 to 8 trees per day.

10. *Skidding.*—The next stage is to skid up the logs or collect in heaps. Generally it will be found economical to do this by animal power, where logs are small and the country flat.

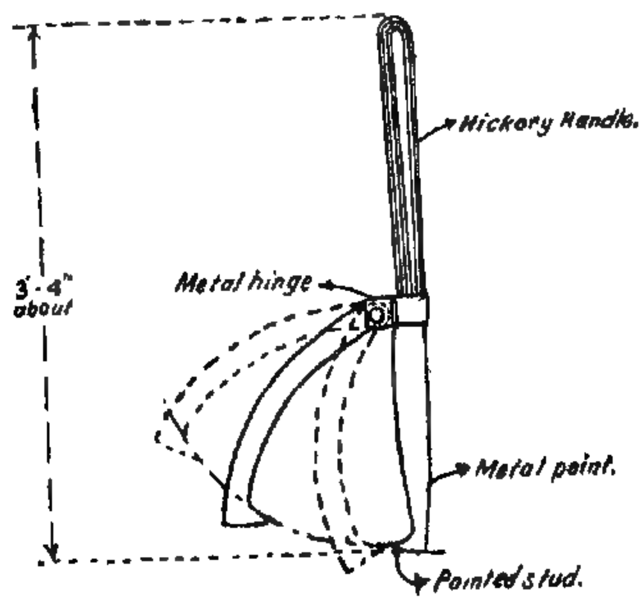
In Senonches teams of 2 or 4 horses (depending on the size of the logs) equipped with skidding tongs ("A") and decking chains were used.



A decking chain is $\frac{5}{8}''$ high tension steel. Piling up to a height of 15′ was done by a team of 2 horses with snatch block and decking chain, the logs rolling up the pile in the bight of the chain.



For handling logs wherever rolling is necessary a "cant hook" is used. This is sketched below. Two skilful men using these hooks can handle logs up to 16′ long with extraordinary ease.



11. *Transport to Mills.*—The method of transport used will depend entirely on local conditions. Where water transport is available and the timber will float it is cheapest and best. Alternatives are, by sled in cold climates, by power skids, by cart, by gravity in wooden shoots in hilly country, or by railway. The latter form was new to the Canadians. They were sceptical as to its possibilities in the beginning, but were converted in the end by its quickness and efficiency. As rail carriage in combination with

gravity is the method probably most suited to India the equipment used at Senonches will be described rather fully

12. *Light Railway Track.* The gauge was 60 centimetre (1′ 11⅝″) (the standard military gauge). Owing to a shortage of pressed steel sleepers metre gauge wooden sleepers, 7 to a rail 7½ metres long, were laid in the main line. (Experience proved that for the main line with wide loads a sleeper not less than 5′ long was to be desired). The rail weighed 20 lbs. per yard run B.S.S.

Points and crossings, of radius 30 metres, were built up on three sections of 7½ metres length over all. Thus by removing a full section of rail, a point and crossing could be slipped in the line without rail cutting.

Curvature.—Sharpest curves used were of 30 metres radius (98·4′). The locos in use took these without difficulty except for the Baldwin side tanks which were liable to derail going bunker first.

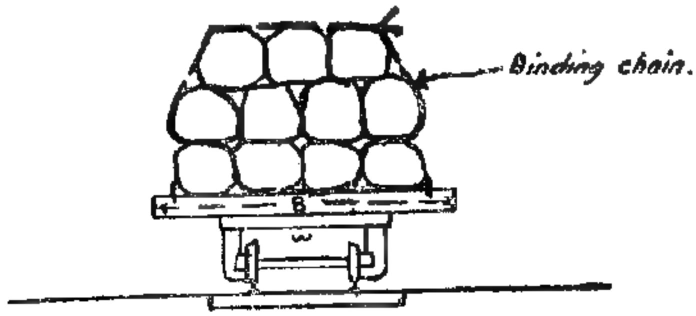
Grades.—At Senonches grades were easy. At Couches, however, a long length of hill-side work, roughly located, with 4 per cent. uncompensated grades and 30 metres radius curvature gave satisfaction.

Rolling stock.—The locos used were 2-6-0 side tank Baldwins (14½ tons) and 0-6-0 Barclays well tank (6·4 tons). The former were easily derailed when reversed and were used only on the main line and branches with wooden sleepers; Barclays were used on unballasted and unpacked skeleton track, but are a trifle light for main line work.

Logging cars were the double-braked standard "F" class flat wagon with detachable stanchions and ammunition well, 20′ 6½″ over buffers and 5′ over body, 2′ 2¾″ from rail to platform, tare 2 tons 2 cwt., load 9 tons 18 cwt. As the logs cut averaged 9′ in length it was necessary to widen the load beyond 5′ to get up to the car capacity. Broad gauge sleepers, cut to 8′ long, were therefore placed across the wagon and fitted with pointed iron studs at 7′ centres. With these and binding chains it was possible to carry 24 logs (over 8 tons) 9′ long; and provided

loading was reasonably well done 12 miles an hour was a safe speed.

For a special logging equipment cars should be all steel, and have special removable bunks. The Baldwin loco would be improved by conversion to a 2-6-2, but I believe a 10 to 12 ton



2-6-2 with flange of middle driver removed would be found altogether more satisfactory. The track requires much maintenance for 14 ton Baldwin.

12 *a*). In general a main line of light railway was laid down through, as near as possible, the centre of gravity of the coupes to be worked. The forest being notoriously wet this line was ballasted and laid in to a fairly high standard. From it short temporary spurs took off to loading and felling points and were solved as soon as each small area was cleared of logs Sectional track, on steel sleepers, worked unballasted by light engines was found quite adequate for these spurs, which were laid in so that no log need be skidded by team more than 400′.

13. *Layout at Mills.*—The loaded, empty and reception narrow gauge lines at the mills have already been referred to. It may be remarked that after trial with various layouts in other forests it was found that that at Senonches was best, *i.e.*, with reception sidings taking off the main lines by a triangle. Train engines, then, worked the train round the triangle into the reception sidings, propelled the loaded to the mills and picked up the empties lying ready. No shunting engine was needed.

APPLICATION TO INDIA.

14. My remarks below assume as a hypothesis that India's timber must be exploited in the immediate future and that some

method of systematised reafforestation will be adopted at the same time. Prices for timber in India were high before the war, by 1917 they were extortionate and ordinary broad gauge sleepers had topped five rupees each.

Yet at the same time the Inspector-General of Forests was stating (in connection with the proposal to lay down a State Railway Creosoting plant) that the supplies of spruce and silver fir in the lower Himalayas were unlimited.

It seems clear that these and other supplies must be utilized and then that new methods must be adopted if timber is to be increased in quantity and reduced in price. And the first needs are cheap transport to the mills, and a satisfactory process of creosoting. For the exploitation of forest in the lower Himalayas it would seem that, speaking generally, a combination of gravity and water carriage and light railways to the mills would be feasible, while for forests in the plains (sal, etc.), light railway transport would appear to meet the case.

Present wasteful methods of cutting and carting the finished product must be replaced by something more modern. I have seen in the sal forests of the Central Provinces, one sleeper being whittled by axe out of an 18″ tree And where saws were used the finished product was, as often as not, in winding and useless as a sleeper. By Canadian methods of taking the log to the mill nothing is wasted. Offcuts are broken up on a hand-saw into planking of from ⅜ to 1″ thick. The sawdust drives the mill and there remains only bark.

Moreover for a scheme of reafforestation in unconserved areas it is desirable that forest areas should be "clean cut," enough trees only being left standing to act as foster-mothers to the seedlings. And it is precisely the "clean cut" condition giving large quantities of timber in a medium area that suit special methods such as have been described.

Special plant.—For India it would be desirable to have the mill framing entirely in steel and built up in small sections readily portable The only sections requiring exceptional stiffness are those carrying the counter-shafting for the saw and carrier drive.

The rest might be as light as consistent with safety. Engine and boilers and main shafting are on the ground.

Should a band resaw be installed a more elaborate arrangement would be necessary. Special brazing, filing and tension machines are required to keep the bands in order. Unless a strong and continuous demand for boarding under 1" could be anticipated I am doubtful if it would be worth while, in the first instance, to lay down such a plant in India.

Again the plant required is considerable and it appears important that in any area selected a complete cycle of operations should be held in view. That is, taking the rotation of pine at, say, 60 years there should be enough timber or timber area in view to provide for 60 years logs for the mills, granted this and reafforestation a permanent industry is secured.

Physical conditions would in all likelihood limit the choice of area in the first instance to the valleys of the larger rivers before they debouch from the hills. Existing irrigation headworks giving ease of collection of water-borne logs will be worth consideration as mill sites, with the added possibility of hydro-electric power.

The friction drive for the carrier would be unsuitable for a hot country and the more efficient "gunshoot" feed (*i.e.*, double acting steam ram) should be substituted; a steam nigger should be installed instead of the pedal worked wooden nigger already described.

Surface and planing machines, a lathe for axe-handles and possibly one more trimming machine or small hand-saw for scantlings should be installed.

Electric light is of course essential and should be extended to supply power for lights and fans in staff quarters.

Staff.—Most of the staff, except the "sawyer," could be trained in India in a comparatively short time. To make an installation immediately successful I consider that one millwright and two sawyers should be obtained from Canada. From conversation with suitable men I gathered that the pay of a millwright must be in the neighbourhood of Rs. 1,250 per mensem and that

of a sawyer about Rs. 1,000. These seem large sums but the output per head of highly paid staff is in practice very high and the actual addition to the cost of timber is not great.

Given this skilled staff there would be no difficulty in filling the rest of the posts with Indian and Anglo-Indian labour.

Scope of undertaking.—Presumably one of the difficulties in the way of the exploitation of Himalayan areas has been lack of transport. Areas near water have been fully cut, more distant areas have been left untouched. It is here that the necessity arises for taking a long view of operations. Taking the rotation of fir at, say, 60 years areas should be selected which will give a complete cycle of operations at the same mill site and so secure a permanent industry. Given this condition and scientific replanting capital sunk in transport, roads, light railways, winding engines and machines, timber dams and so on would be well justified

Physical conditions are here the ruling factor and must limit the choice of areas to be examined in the first instance. But it is urged that the Punjab river valleys would well repay examination by an Engineer with a knowledge of Bush work and transportation, while the possibility of utilising Canal Head-works near the hill foots on the larger rivers as collecting and mill sites, with the possibility of hydro-electric power is worthy of consideration

Marketing.—An assured market for sleepers exists and it need not be doubted that a suitable process of creosoting will be evolved. There remains a large market for planking and scantlings which might well be fed in part with creosoted soft timbers. It has been objected that consumers in India insist on teak for structural purposes. The reply to this is that they have never been offered anything else at reasonable prices and in quantity and that it may be anticipated that the supply here would make the demand. In any case the great shipbuilding programme which is certain for the next decade will keep teak at a prohibitive price.

Machinery manufacturers —A few addresses of machine manufacturers and suppliers are appended :—

Cant Hooks ... Thomas Pink, Pembroke, Ontario.

Saws (Lance tooth) (1) Shirley and Dretrich, Galt, Ontario.

(2) Disston, Galt, Ontario.

Axes ...	Willard Vale Manufacturing Coy., Dundas, Ontario.
Skidding Tongs ...	Thomas Pink, Pembroke, Ontario.
	Wood Valance & Co., Toronto.
Decking Chains ..	Ashdown, Winnipeg, Race Lewis, Toronto, Marshall Wells, Toronto.

Cant hooks and skidding tongs could well be made in India, if samples were obtained. Saws, circular and lance tooth, decking chains and axes should be obtained from Canada.

NOTES ON THE GERMINATION OF *QUERCUS SERRATA*, THUNB.

During the autumn of 1916 the writer noticed that there was a very heavy crop of acorns of *Quercus serrata* in the woods around Maymyo, and also that the acorns varied much in size. It seemed worth while to sow some of these seeds to see whether the germinating power and the resulting seedlings would vary according to the size of the acorns. A quantity of seed was therefore collected and 200 of the largest acorns and 200 of the smallest were selected. All were sound. The 200 large acorns weighed 2 lbs. 6⅝ oz and the 200 small acorns 1 lb. 4¼ oz., so that the large acorns weighed nearly twice as much as the smaller acorns. They were sown in adjacent beds in a private garden, where they would not suffer from interference. The writer was unable to watch the germination, but exactly a year after sowing all the seedlings in the beds were removed, counted and measured, with the following result:—

Size of acorns.	Number of seedlings found	Average height of stem in inches	Average length of root in inches.
Large ..	108	4·4	17·2
Small ..	94	5·8	17·4

It would appear, therefore, that the size of the seed in this species has little effect on the crop that may be expected from

sowings. The writer hopes to be able to carry out further experiments of this nature and suggests that any Forest Officer who has any similar data regarding seeds of Indian Forest trees might publish them in the *Indian Forester*

A. RODGER, I.F.S.,
Forest Research Officer, Burma.

September 1919.

HORNS OF A LARGE KASHMIR STAG.

SIR,

The enclosed photo (Plate 32) of the horns of a large Kashmir Stag shot by me may interest some of your readers. The measurements of the horns taken by Major Wigram, K. O. S. Borderers, the Secretary of the Kashmir Game Preservation Department, are as follows :—

Length Left 49, Right 51½ inches.
Girth—6½ inches.
Tip to tip—21 inches.
Outside spread—41½ inches
Points—6 + 5 = 11.

The stag was shot on the afternoon of the 12th November 1918 in one of the side Nullahs of the Liddar Nullah, within a day's march of Bijbehara.

Snow fell early in October which must have driven the stags down to the lower valleys earlier than usual. After shooting in the Kalan Nullah nearly opposite the village of Reveil in the Sind Valley, we crossed over the pass between Haien and Shalimarbagh on the Dal lake, marched up the Main Valley of the Sutlej to Bijbehara, then went up the Liddar Valley and camped between Aru and Liddar west. Finding that the big stags had gone south, we went back to the Moondlam Nullah, a short distance above the village of Pahlgam, where I got a small ten pointer measuring 36½ inches and decided not to fire at anything less than a 12 pointer or a really good ten pointer We must have got within shooting distance of at least ten shootable heads before seeing the stag killed.

Photo. Mechl. Dept., Thomason College, Roorkee

HORNS OF A LARGE KASHMIR STAG.

We first saw him in the evening just before dusk come out of a wood situated in the central branch of the Nullah, preceded at fairly long intervals of time first by 6 or 8 hinds and then two ten pointers who all gazed towards us. In the evening light through a telescope, the horns looked immense and I at once decided that I would not fire at anything else. The Shikari did not say what he thought the horns measured but told me he had never seen so fine a head. I heard afterwards he told the cook he thought they were over 50 inches.

We did not get a shot that evening as he was too far off but got up very early the next morning and going a long way round came down the spur above the grassy slope he had come out on. After waiting for some time we heard the clatter of a stag's hoofs galloping down a hill side to our left and waited for the stag to pass beneath us to get back to his wood, but were disappointed, as he went down a side valley and we did not see him. We went out morning and evening for the next two days but did not come across him, though we came across several other smaller stags including one ten pointer, my Shikari said was 46 inches.

The next day morning and evening we went through the wood he lived in up to a ridge commanding the slope on which we first saw him without seeing anything. There was something in the wood above us in the evening which disturbed the game seriously, probably a leopard or a bear.

The day after, in the evening, we saw him coming out, just as it was getting dusk, on the same slope we had first seen him on and approached him as rapidly as we could, we avoided a small herd of hinds, but could not avoid two ten pointers, who barked when they saw us, warning the stag which we did not see. The next day was the last. We went up the northern branch of the Nullah in the morning and watched two hinds, one with a broken shoulder limping about on three legs for some time, but did not see the stag. The camp was moved to Martand and after the ponies had left the valley was once more quiet. We started out after an early tea up the central branch of the valley and soon spotted the big stag emerging from his wood on to the grassy

slope on which we had first seen him and went as quickly as possible up through his wood to the ridge commanding the grassy slope. We had brushed away the dead leaves along the track we had come down so could get up to the spur without making any noise and were rewarded on arriving at the crest of the spur to find the stag standing in the open with a couple of hinds looking towards us.

After waiting for a few minutes to get breath, I very slowly raised the rifle and fired, hitting the stag who was about 100 yards distant well behind the shoulder. He went up the hill a few paces, turned suddenly downhill, stumbled, fell, rolled over and finally slid down the steep slope out of sight. The Shikari could not find him for some time but eventually saw him well below us with his horns caught up in some shrubs In falling he broke off one of the small tines on the left antler, and just the tip of the longer right antler.

The stag was a local celebrity and was known to come down to the lower Nullahs every year about November. He had been missed several times and was believed to the villagers to be possessed with a spirit who protected him and made him invulnerable. Kashmir stags wander about a great deal being driven down from the higher grazing grounds by the snow and gradually coming down to lower elevation until in the middle of winter they are found even in the Sutlej Valley itself. As the snow melts, they move up again and in April are, I was told, found in the wooded slopes around Baltal in the Sind Valley and at similar altitudes in other valleys. One has consequently to work hard or be lucky if one wants to get a really big stag as it is impossible to say which particular valley will hold him. There are still large numbers of Kashmir deer as is evidenced by our seeing 60 hinds and small deer at one and the same time on one grassy slope. We hardly ever went out without seeing an animal of sorts, chiefly it must be admitted either hinds or small stags. As the bodies of all the stags are about the same size one wants a telescope to estimate accurately the length of the horns.

C. G ROGERS, I.F.S.,
Chief Conservator of Forests,
Burma.

MAYMYO :
11th August 1919.

The Secretary of the Bombay Natural History Society writing on the 2nd September says, "The record head appears to be one which was given to Colonel King of the 14th Hussars and measured by A. O. Hume, in the fifties. The length *inside* the curve was R. 52, L. 55½", circumference at Burr 10". On Colonel King's death this head passed to another officer and cannot now be traced.

The first head on the list given by Rowland Ward apart from the above is one from the Liddar Valley measuring 48½" on outside curve

C G. ROGERS, I.F.S.

EXTRACTS.

WOOD DISTILLATION.

[The utiliza ion of inferior kinds of timber and the refuse from fellings has often been a subject of enquiry and some have gone so far as to forecast the development of an extensive industry in India by means of wood distillation. We, therefore, take the liberty of reprodu ing Part I of Messrs. Watson and Sudborough's paper on wood distillation which appeared as Vol. 2, Part VII of the Journal of the Indian Institute of Science. The second part of the paper gives results of the distillation of some South Indian woods.]

PART I—GENERAL.

BY H. E. WATSON AND J. J. SUDBOROUGH.

I.—Introduction.

The manufacture of charcoal from wood appears to be one of the earliest chemical operations carried out by pre-historic men. In all probability the process was found out shortly after the discovery of metallic iron, as although the earliest iron appears to have been made by heating a mixture of wood with iron ore, yet specimens made at a slightly later date bear evidence of the use of charcoal in their manufacture.* In this connection it is interesting to note that the chief sources of such iron were Central and Southern India, so that there is good reason to believe that India was the first country to produce charcoal in any considerable quantities.

At a somewhat later period the art of wood distillation had made considerable progress, for it is on record that the Egyptians produced wood vinegar and tar and used them for embalming their dead.†

Coming to more modern times, the charcoal burner plays a considerable part in the myths and legends of all European

* W. H. Schoff, J. Amer Oriental Soc, 1915, 35, iii, 224.

† O. Vogel, Chem. Zeit., 1907, No. 82.

countries, and, as far as can be ascertained, his method of carbonizing wood has persisted practically unaltered for centuries.

In this process the wood is built up into a stack, usually in the forest where it is felled. The exact design of the stack naturally differs from place to place, but the principle is the same in all cases. Generally speaking, the wood is carefully arranged in the form of a hemisphere or a paraboloid round a central core consisting of several vertical billets. The wood is packed tightly except for a few air passages, and when the stack is complete the central core is removed, forming a chimney, and the rest of the wood is covered with a layer of leaves or moss, and finally with a covering of turf or mud. The combustion is started by throwing several small pieces of burning wood into the chimney. As soon as the stack proper begins to burn, the top of the chimney is blocked up and the supply of air is very carefully regulated by removing portions of the outer covering. The air enters at the bottom, and the products of combustion are allowed to escape, first near the top of the stack and then lower down, until the whole mass is thoroughly charred. The progress of the combustion can be ascertained by noting the colour of the smoke. When carbonization is completed, all openings in the stack are tightly closed with moist earth, and the whole is left to cool for several days. The stack is then opened up, and the charcoal collected.

In this process, the temperature attained in the stack is considerable, being frequently as much as 700°C., and the charcoal produced is of a high grade, possessing the following properties :—

(*a*) Great density and hardness.
(*b*) High calorific value.
(*c*) High carbon content and very little volatile matter.
(*d*) Is not easily ignited and burns with practically no flame.

On the other hand, the yield is small, being only about 20 per cent. on the weight of the wood charred, compared with some 30 per cent. obtained by the more modern closed retort processes. In the latter, however, a certain quantity of extra wood is required for fuel which reduces the nett amount, but even when allowance is

made for this there is still a considerable balance in favour of the closed retorts.

The stack process is very convenient for producing charcoal to meet small local demands for domestic use or minor metallurgical operations. It requires no extensive organization for the supply of wood or the disposal of products, a fair quantity of charcoal can be manufactured with a minimum amount of labour, and no capital is necessary, so that work can be carried on intermittently or to suit the season.

For these reasons the process is admirably suited to India and particularly to South India, where, owing to the lack of coal, charcoal is required in every village; consequently the number of charcoal burners is very large.

In modern processes of wood distillation the valuable by-products, which in the old stack process were usually allowed to pass into the air in the form of vapour, are collected and sold in the crude form or worked up into marketable derivatives.

To effect this, the wood is heated in closed iron retorts or occasionally in masonry containers. In nearly all cases the heating is external and the vapours and gases are led from the retorts by suitable outlet pipes into cooling coils or tubes made of copper, in which the greater portion of the vapours condense forming a dark coloured liquid. The uncondensed gas consists mainly of carbon dioxide (about 59 per cent.) and carbon monoxide (33 per cent.) with smaller amounts of hydrogen and various hydro-carbons. This gas has a nett calorific value of about 850 Cals. per cubic meter, and is usually burnt under the retorts since it effects a saving of about one-third of the fuel required for the actual distillation. It may also be even more profitably used for the production of power by means of gas engines.

The most important by-product is the liquid collected from the condensers. If this is allowed to stand it separates into two, or under certain circumstances, three layers. One of these, the brown watery liquid, is known as pyroligneous acid, while the residue constitutes wood tar. The pyroligneous acid contains a certain amount of tar in solution, but consists mainly of an aqueous

solution of acetic acid and methyl alcohol, together with a little acetone. More than 20 other substances are also commonly present, but in small quantities only, and are of very slight importance.

The tar is a complicated mixture, and differs very considerably in its composition according to the type of wood from which it is made. Tar from hard woods is heavier than water, and on an average not more than 35 per cent., including 15 per cent. of water and acetic acid, is volatile at temperatures below 230°C.; and 10 to 15 per cent. of the volatile oil boiling below 230° consists of creosote and guaiacol. On the other hand, tar from resinous woods such as fir is lighter than water, and about 60 per cent. is volatile below 230°, and this volatile portion consists largely of turpentine and resin oils.

From whatever type of wood the tar is obtained it is separated into two portions, (*a*) the tar which settles out from the pyroligneous acid, and (*b*) the tar which is soluble in the pyroligneous acid. The latter is of little value, and is usually burnt under the retorts after removal of the acetic acid.

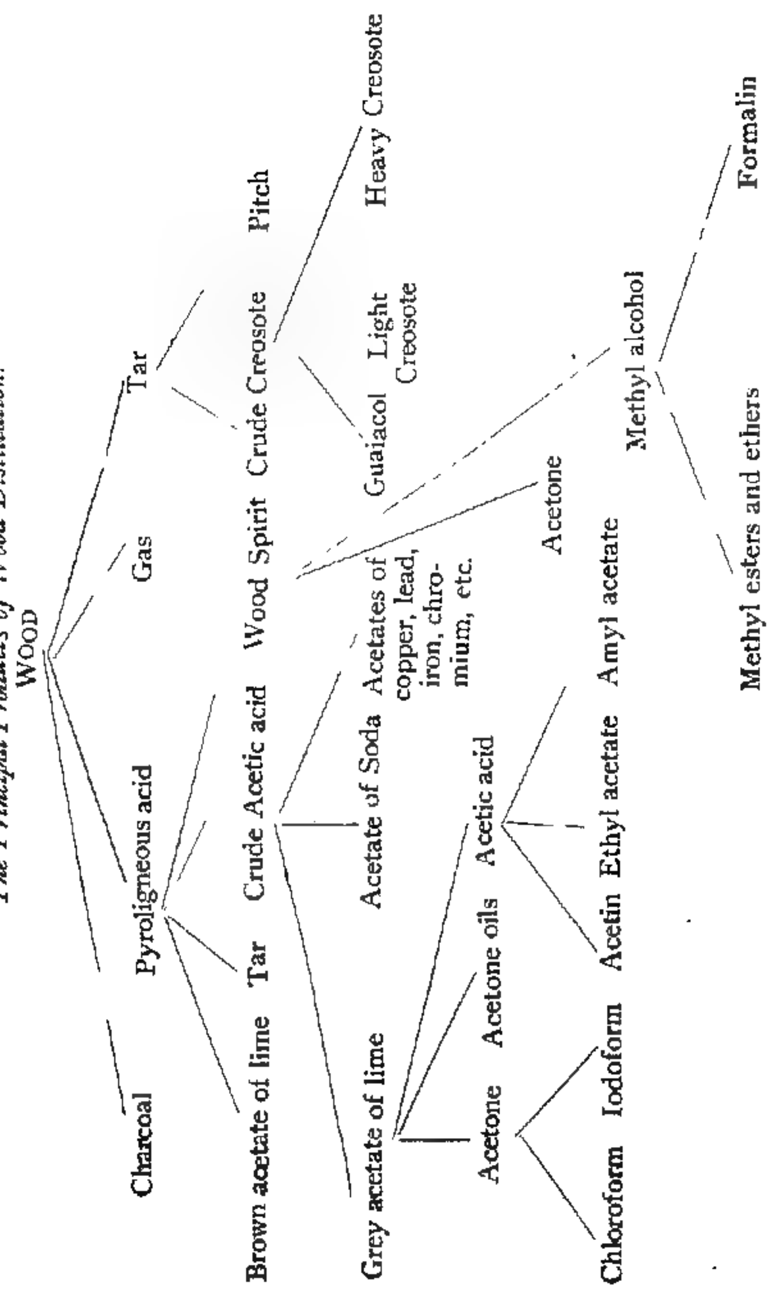
Diagram No. 1 shows the various products mentioned above, and also indicates some of the more important derivatives which can be manufactured from these primary substances.

The distillation of wood with recovery of by-products, although of comparatively recent origin, has now developed into an industry of enormous dimensions. The first factories to be established contented themselves with the production of a crude acetic acid and acetates, in addition to the charcoal, as no use had been found for the wood spirit or tar, but now four main primary products are made, *viz.*, charcoal, grey acetate of lime, wood spirit and tar. In many cases plant for the production of pure acetic acid and acetone is installed at the distillery, and other products derived from the primary ones are manufactured on an ever increasing scale.

It is estimated that about three million tons of wood are distilled every year throughout the world for the sake of the by-products, producing approximately 1,50,000 tons of acetic acid,

DIAGRAM No. I.

The Principal Products of Wood Distillation.



and 35,000 tons of wood spirit. In the United States, whole forests are cut down, and the production in that country is about half that of the total. The industry has also assumed large proportions in Canada where half the remainder is distilled, while the remaining quarter is treated in Europe, mainly in Germany and Austria.

The greater portion of the acetate of lime is converted into acetic acid which is used in dye making, for edible purposes, and for the production of salts and other secondary products such as esters for which there is a large demand. Many of the salts are used in the dyeing industry, while the esters may be used for flavouring and perfumery purposes or in the synthesis of more complicated chemicals. Another most important product, obtained by the distillation of the grey acetate, is acetone which is largely used as a solvent, particularly in the manufacture of cordite as well as being employed in the manufacture of chloroform and iodoform.

Within the last few years it has been found possible to make acetone from the starchy material of cereals by a fermentation process, and this has been largely developed owing to war conditions; it is, however, difficult to say which of the two methods will survive in normal times.

Wood spirit is used in a partly refined form for the denaturing of alcohol, and for the preparation of varnishes, and enormous quantities are consumed in this way. Many thousands of gallons are carefully purified giving methyl alcohol, which is essential for the manufacture of many important dyes, and is the material from which formalin is made.

From the tar, drugs such as creosote and guaiacol can be separated and even the charcoal dust is now worked up into briquettes to be used as fuel.

Hence it will be seen that wood distillation, although not comparable with the distillation of coal, gives rise nevertheless to an extraordinary variety of products which are used in industries of all kinds. Many of these products must be regarded as indispensable for the manufacture of other articles, and it is

certainly no exaggeration to apply to this important operation the term " key industry."

II.—Raw Materials.

Any material of a woody nature will give on distillation charcoal and pyroligneous acid, but in practice only certain classes of wood are usually treated. These are (1) jungle trees which are useless for timber, (2) the branches, roots, and other waste portions of timber trees, (3) refuse from saw mills, (4) waste products such as palm kernels, the outer portions of the coffee bean, and particularly the residues left after expression of the oil from olives.

With regard to size, finely divided matter such as saw-dust, or the waste products just mentioned must be treated in special retorts while very small branches of an inch in diameter or less, are usually used as fuel, as the charcoal is of little value. The maximum size, on the other hand, depends on the time taken by the distillation. In the large American stacks, logs as large as 15 inches in diameter become completely carbonized For the ordinary large size retort in which the distillation takes about 20 hours, it is not advisable to use wood of greater diameter than 7 to 8 inches and anything larger than this must be split.

The length of the pieces of wood used is usually adjusted so that an integral number of lengths will fit into the retort or truck when placed end to end. A convenient length is about 2 to 4 feet, but longer lengths than this may be used when the wood is straight and uniform.

The quantity of moisture in the wood is of very great importance, and exercises a considerable effect upon the yield of by-products.

When freshly felled, wood contains much moisture and the amount varies with the kind of wood and the season at which it is felled, but on the average the quantity for the harder kinds of wood is about 40 per cent. If wood containing this quantity of water is distilled, a very large amount of fuel is required, both for the original distillation, and for the subsequent redistillation and

evaporation of the resulting pyroligneous acid. This extra fuel is about 55 per cent. of the amount required for the distillation of wood containing only 20 per cent. of moisture. At the same time a retort designed for treating dry wood can only be used for a much smaller quantity of abnormally wet wood, as more time is required for distillation of the excess water and the time period for each charge is increased. Attempts to shorten the time by appreciably increasing the heat of the furnace result in damage to the retorts. Owing to this fact, the output of a factory may be very much diminished by the use of wet wood, while the working expenses remain the same, and it has been estimated that, for a given outturn, these expenses may be easily increased by 50 per cent. through using improperly dried wood.

A third disadvantage of wet wood is due to the fact that such wood gives a proportionately smaller quantity of acetic acid on distillation. Thus 167 lbs. of wood with 40 per cent. of moisture will give considerably less acetic acid than 125 lbs. with 20 per cent. of moisture, although the amount of perfectly dry wood is the same (100 lbs.) in both cases. The yield of charcoal is little altered, while actually a little more wood spirit is obtained, although this increase is not nearly sufficient to compensate for the loss of the acetic acid.*

It will thus be seen how necessary it is for economic working to make sure that the wood used is not unduly wet. On the other hand, it must not be too dry. If wood containing only 2 per cent. or 3 per cent of moisture is heated in a retort, at a certain temperature a most violent, reaction, almost approximating to an explosion, will set in, and even if the condensing plant is sufficient to cope with the sudden rush of gas which results, the temperature inside the retort will rise so high that there will be much decomposition, and the yield of products will be greatly reduced.

In practice it is found that wood with a moisture content of 15 to 20 per cent. is best for distillation in order to ensure a moderately quiet run. This quantity is practically the amount

* Ark Kem' Min. u. Geol., 1908 3, 9.

which is found in "air dried" wood, that is to say wood which has been cut and exposed to the atmosphere for a considerable period. In Europe and America the time usually allowed for drying is at least a year, but in India it would be less owing to the higher temperature.

The chief objection to the air drying of wood is the amount of capital necessary to stock a whole year's supply, and attempts have been made to dry the wood artificially. It has been found that this can be done in three days, but apart from the great danger of fire, the cost is so high that ordinarily the quick process of drying cannot compete with the other method. Suggestions have been made to utilize the waste heat from the retorts and other plant for drying purposes, but calculation shows that even if the whole of such heat could be utilized it would not suffice to reduce the moisture content from 40 per cent. to 20 per cent. The most that can be done with practical success is to heat the air dried wood to about 100°C. by means of the waste flue gases before running it into the retort. In this way about 5 per cent. of the total fuel can be saved.

III.—The Chemistry of Wood Distillation.

Very little is known about the actual chemical change which takes place during the distillation of woody tissues, a few facts, however, have been established.

The chief chemical constituents of woody tissues are the lignocelluloses and water. The lignocelluloses consist of lignin and cellulose in varying quantities, and it is from these two substances that the various by-products are derived.

Lignin is less stable than cellulose and in the estimation of cellulose in tissues is usually decomposed by chlorine, bromine or hydrogen peroxide. The actual products present in the distillate are probably not the primary products of decomposition of the cellulose and lignin molecules and it is impossible definitely to state the manner in which such simple substances as methyl alcohol and acetic acid are obtained from the complex molecules of cellulose and lignin.

P. Klason, Heidenstam and Norlin appear to have established the fact that if wood, represented by the formula $C_{42}H_{60}O_{28}$ is heated to 400°C., the reaction up to 275° is endothermic and heat is absorbed, at 275° the reaction becomes exothermic and heat is evolved. The complete distillation is exothermic, the heat evolved being about 6 per cent. of the total heat of combustion of the wood distilled. The cellulose gives acetic acid and no methyl alcohol, while the lignin gives both, so that the proportion of these two substances in the distillate varies considerably with the variety of wood distilled. The charcoal formed at this temperature, excluding the ash, has the empyrical formula $C_{16}H_{10}O_2$, that is to say, it contains only 82 per cent. of carbon. In addition there is a large amount of decomposition into water, carbon monoxide and carbon dioxide.

In the ordinary closed retort the highest temperature reached is usually about 400° and the reaction may be divided into three stages :—

1. Up to 170°. The evaporation of the water in the wood by means of external heat.

2. From 170° to 275°. Further heating of the wood combined with some decomposition, and evolution of carbon monoxide and dioxide. Acetic acid is formed, but very little methyl alcohol or tar.

3. Above 275°. The exothermic reaction. The temperature may rise to 400° or even higher. Large quantities of gaseous hydrocarbons are evolved together with much acetic acid, methyl alcohol and tar.

In some cases, for instance if the wood is very moist, it is necessary to supply more heat at the end of the third period to bring the charcoal to a sufficiently high temperature, otherwise the carbon content will be low. Charcoal which has been heated to 330° is not properly black, and contains only 73 per cent. of carbon. At 350° this figure rises to 76·5 per cent. and at 400°, as already mentioned, it is about 82 per cent.

When the wood is allowed to cool in the retorts a fourth stage may be added to the above, namely, the absorption of the gaseous hydrocarbons by the charcoal, followed apparently

by decomposition when so absorbed. In this way the carbon content of the charcoal may be quite appreciably increased.

It will be observed, that in the third period, the greatest amount of gas of high calorific power is given off, and it is just at this stage that external heat is not essential, consequently it is fundamentally wrong to burn the gas under the retort from which it is being evolved It should be used for heating another retort at a different stage, or for power-producing purposes.

The following description given by Juon* applies to a large Ottelinska kiln (class 1, p. 90) in which the hot gases from an external furnace pass through that kiln, and illustrates the fact that the distillation proceeds quite differently when the type of retort or kiln is altered. At temperatures below 200°C. the liquid which distils over is mostly water, and the gases, the volume of which is relatively small, consist of carbon dioxide (68 per cent.), carbon monoxide (30 per cent.) and hydrocarbons (2 per cent.). At temperatures between 200° and 280° acetic acid vapour accompanies the steam, and the gas, the volume of which is still small, has much the same composition as before. Between 280° and 380° the volume of gas is large, the percentage of hydrocarbons is about equal to that of the carbon dioxide (35—36 per cent.) and the calorific value of the gas increases appreciably; wood spirit and light tars also pass over with the water and acetic acid. At temperatures between 380° and 500° heavy tar appears in the distillate and the percentage of hydrocarbons in the gas increases further (49 per cent.), if the temperature is increased to 700° the gas becomes rich in hydrogen and large quantities of tar and paraffin are obtained in the distillate.

The substances mentioned among the primary products undergo considerable decomposition before leaving the still, and one of the chief problems in wood distillation at present is to increase the yield of valuable products by reducing to a minimum their decomposition in the still to more or less valueless substances.

* E. Juon, Stahl u. Eisen, 1907 733.

Acetic acid is comparatively stable, but it appears probable that at temperatures in the neighbourhood of 300°, and especially when it in in the nascent state, *i.e.*, just being produced, it is acted upon to some extent by steam. This reaction would certainly be accelerated by contact with a substance presenting a very large surface, such as charcoal. It is quite possible in commercial working for the three stages of the decomposition mentioned above, to take place concurrently. If, for example, a large moist log is rapidly heated, the surface may have reached the exothermic stage, before the interior is dry. Under these conditions much steam will be evolved, and will come in contact with the hot, newly formed acetic acid and decompose it. The result is greatly increased yield of gas, and a decreased yield of acid. This is commonly found in practice when the wood is too moist and the firing too rapid. Consequently an attempt should be made to complete the first stage of the reaction before the third one starts. In addition to the steam given off in the first stage, a certain amount is evolved in the second stage, but this does not appear to have such an adverse effect upon the yield of acid, possibly because of its dilution with other gases.

In contrast to acetic acid, methyl alcohol does not appear to be decomposed by an excess of superheated steam, but unregulated heating of the contents of the retort has an enormous influence on the yield, and if the wood is very slowly dried, so that the subsequent exothermic reaction is so violent that temperatures much above 400° are attained, the quantity of methyl alcohol given off is very small. By carefully controlling the violence of the exothermic reaction, however, a much higher yield may be obtained. For example, R. C. Palmer,* by careful regulation of the temperature in a retort of the ordinary commercial size, was able to obtain 30 per cent. more methyl alcohol and about 6—10 per cent. more acetic acid than is usual with the same woods distilled in the ordinary way.

The primary products, as they make their way through the hot still and outlet pipe into the condenser, undergo secondary

* J. Indus. & Eng. Chem., 1915, 7, 663.

decompositions This is shown by deposits of carbonaceous matter on the walls of the still and in the pipe. This deposit is a source of considerable trouble, and even the largest outlets require frequent cleaning to prevent their becoming completely blocked. In large retorts it is now customary to provide two outlet tubes one near each end so that the gases have to traverse a comparatively short length of heated surface. The result is a considerably increased yield of by-products. In some installations an exhaust fan is fitted with the object of removing the gases in the retort as rapidly as possible, the pressure in the retort being kept a little below that of the atmosphere. This system appears to be based on a fallacy, as the gases do not move appreciably faster and it has the disadvantage that if there is any leak in the retort, air can enter and cause local combustion.

In addition to losses of alcohol and acetic acid, a too rapid heating may cause a diminution in the quantity of charcoal. E. Juon * has shown that in large masonry ovens in which the temperature may reach 700° or more, a large proportion of the gas evolved above 500° is hydrogen, while the quantity of carbon monoxide also increases, indicating a certain amount of decomposition of the charcoal by steam. This reaction probably takes place to a smaller extent in lower temperature distillations especially when local overheating occurs.

It is clear that there is still need for further research, especially in the direction of the reactions which take place in the retorts, and it is probable that further investigation will result in an increase in the efficiency of this important part of the operation.

Although much of what has been stated in this section may appear to be of little or no interest to the practical wood distiller, in reality many of the points mentioned are of vital importance. The facts prove beyond doubt that, for the purposes of recovery of high yields of wood spirit and acetic acid, it is essential that the distillation should take place *slowly and that high temperatures during the course of the distillation should be avoided.* This may be accepted as one of the most important conditions which the

* Stahl u. Eisen, 1907, 733, 771.

distiller must keep in mind. It is necessary to remove a considerable portion of the water present in the wood before raising the temperature to 275°, and when this temperature has been reached, the firing of the retort must be carefully regulated by means of the dampers, so that less external heating takes place during the stage when heat is developed by the decomposition of the wood itself.

IV.—Modern Retorts.

The retorts used at present for distilling wood may be divided into five classes:—

(1) Kilns of large capacity, worked intermittently.

(2) Small fixed retorts discharged by hand.

(3) Small portable retorts.

(4) Large retorts or ovens with separate coolers, and mechanical handling of the wood in trucks.

(5) Continuous mechanical plant.

(1) The first class of retort is usually constructed of masonry in the form of a truncated cone or dome, and may be as much as 24 feet in diameter and 18 feet high, holding 150 tons of wood. The heating is effected by the combustion of a portion of the wood, just as in the old fashioned stacks, the only difference being that the by-products are collected. The large American or Meiler ovens are of this type, and are stated to be economical to erect and to work. As in this process an appreciable portion of the wood in the kiln is lost by the process of combustion, it has become customary in certain districts to burn low grade material, such as sawdust or twigs, in an external furnace adjoining the kiln and to admit the hot products of combustion to the bottom of the kiln. The Schwarz oven and its modifications, *e.g.*, the Ottelinska, which are extensively used in Sweden, are examples of this type. In such ovens it is essential that the hot gases shall be evenly distributed through the wood. This is usually accomplished by admitting the gases into the kilns through a branching system of channels with openings at the bottom of the kiln and erecting several chimneys attached to the periphery of the kiln.

Enormous retorts of this class have actually been constructed of sheet iron, heated externally by flues and internally by pipes through which hot gases pass; their cost, however, is very high.

Kilns of the dimensions indicated have usually been erected where immense quantities of charcoal are required for the production of iron or for other metallurgical operations and the yield of by-products unimportant, but they appear to be falling into disuse because of their inefficiency and the difficulty of controlling the distillation.

2. The second class of retort consists of a sheet iron cylinder, usually horizontal with a door at one end, and an outlet pipe at the other. It holds from 1 to 2 tons of wood, and two or more such stills are generally set in a system of flues from an external furnace.

Distillation occupies about 12 hours, and soon after the flow of distillate has ceased, the door of the retort is opened and the charcoal raked out rapidly into an airtight iron box which is immediately closed.

Most of the German, Austrian and Russian, as well as the older British installations are on this system. As opposed to the last (No. 1) it is characterised by being nearly continuous in operation, as the retorts after discharging are at once refilled without cooling.

3 The third class of retort is made of iron and is similar to the last, but it is suspended by a flange vertically in the furnace. It is attached to the condenser by an easily broken joint, and when the distillation is finished the condenser is disconnected, the whole retort lifted bodily from the furnace by means of a crane and carried away to the cooling house, and a fresh retort previously filled with wood is immediately put into the place it formerly occupied. When the retort is cool, the lid is taken off, the charcoal removed and fresh wood introduced.

This retort is chiefly used in France, Belgium and Italy. It usually contains about 2 tons of wood, since larger sizes are difficult to manipulate owing to their increased weights. The chief advantage which this type possesses is that the charging,

owing to its being carried out cold, can be more carefully controlled than in a hot retort, and consequently very little space need be wasted. On the other hand, the continual movement, and sudden changes of temperature greatly shorten the life of the retort and the furnace, and thus materially increase the renewal charges of the factory.

On the Pacific Coast of America this type of retort is modified by having an open-work iron basket fitting into the retort. This basket is filled with wood, lowered into the hot retort and the retort cover bolted on. After distillation the basket containing the charcoal is lifted into a cooler and a fresh basket introduced into the retort. It is claimed that by this means considerable saving in wear and tear of retorts and furnace and also a saving in fuel are brought about.

4. The fourth kind of retort is being largely used in modern installations as it is the most economical, and gives the highest yield of by-products, as well as charcoal of very good quality. The retort proper is a horizontal iron cylinder made of stout boiler plates well rivetted, is about 45 feet long and 6 feet in diameter, and holds about 12 tons of wood. This is set in a furnace, fitted at the ends with doors which are closed by means of nuts and bolts. The escaping gases are carried off by means of wide exit tubes at the top. Along the bottom of the retort run rails which carry the four trucks upon which the wood is loaded.

Opposite the retort proper stands another similar iron cylinder which is used for cooling purposes. As soon as the distillation is completed, the door of the retort is opened and the trucks, carrying the charcoal, are drawn out of the retort and into the cooler by means of an electric motor or other mechanical contrivance. The door of the cooler is shut, and a fresh charge of wood, ready loaded on another set of four trucks, is run into the retort. With proper care the whole of this operation can be carried out in half an hour, and as it is usual to arrange for the distillation to occupy the remainder of 24 hours, it will be seen that the process is practically continuous. The loss of charcoal by combustion while passing from the retort to the cooler is quite negligible

owing to the very short time (a few seconds) required for the transference.

The trucks consist of an iron frame-work which fits fairly closely into the still and runs on small wheels. The open-work structure allows of the escape of the gaseous products from all sides and a close fit is necessary in order that space may not be lost.

In some factories the loaded trucks are placed in a pre-heater before being run into the retort. This heater is also an iron cylinder and is heated by the waste flue gases This pre-heating serves the purpose of removing a small amount of moisture and at the same time heats the wood before entering the retort proper, and both these mean a slight saving in fuel costs.

The cooler may be either left to cool slowly in the air or may be cooled by allowing cold water to run over it.

5. The last type of retort is one in which the operation of distillation is continuous. Such retorts are generally only used for the treatment of special classes of materials such as sawdust, chippings, waste from dye wood or tan wood extraction factories, and the residue from olive oil presses and are consequently not of wide application. The general principle is that the wood is carried through the furnace on a mechanical conveyor and distilled during its progress. Many different means of effecting this have been devised, but it is not proposed to describe them in detail. The retorts are all complicated, wear out rapidly and the yield of by-products from the class of wood dealt with is very low. Continuous retorts for dealing with cord wood have also been invented, but the same remarks apply to them.

Whichever type of iron retort is used, considerable care is required in setting it in its furnace so that the best results can be obtained. It is essential that the arrangements are such that the wood in the retort is heated as uniformly as possible and it is also necessary that no portion of the retort should be directly heated by the flames from the furnace, as this produces over-heating and a burning out of a number of plates and necessitates continual repairs or even complete replacement of the retorts.

The heating is always carried out by hot gases and so arranged, whether the retort is of the vertical or horizontal type, that the gases come first in contact with the bottom of the retort. As this necessarily means that the lower part of the retort gets worn out first, horizontal retorts are so set that after a time they can be moved round with readjustment of exit pipe so that the top becomes the bottom.

Various devices for the even distribution of the hot gases around the retort have been adopted, and although the description of these may appear simple, the actual accomplishment of an even heating, upon which the success of the distillation largely depends, is always difficult to attain. Spiral shaped flues have been used but do not appear to be very efficient. A method highly recommended is to carry the hot gases along a fire brick channel just below the retort and allow them to escape through numerous small holes in the roof of the channel so that the retort becomes heated at a number of different points at the same time.

In setting a retort in a furnace it is advisable to keep all the weight off the brick-work. This is accomplished either by hanging the retort by means of rods from I beams or by using lugs on the retort and placing iron pipes or posts under the lugs, in all cases allowing for the expansion of the retort. As the masonry around the retort shows great tendency to crack, the walls should be tied through and through with long rods.

The chief factor which decides the capacity of the retort to be used is the length of time which is to be taken for completely charring the charge. This can vary from twelve hours for a small retort to twenty days for big kilns. Before deciding the relative dimensions of the retort several points have to be considered. It is obvious that the wood in a long, narrow cylinder would be much more uniformly heated that in a short, broad cylinder, as in the latter case the wood in the interior would be only just warm when that close to the walls was already well charred. The long, narrow retort, on the other hand, has the disadvantage that the products of distillation have to traverse a considerable length of heated surface before leaving the retort

and hence the amount of decomposition of the acetic acid would be high. To minimise this decomposition numerous exit tubes would have to be attached to the retort. The tendency on the whole has been to increase the ratio length / diameter and to provide at least two exit tubes. At one time a common dimension for a retort was 9 feet × 4 feet, whereas now stills 45 feet × 6 feet are frequently used.

Attention has already been drawn to the deposit of hard carbonaceous matter in the outlet pipes and retorts. The deposit has to be removed from the outlet pipes as otherwise their capacity for carrying off the vapours becomes less and they may ultimately become completely choked. The interior of the retort must also be scraped down periodically, otherwise the incrustation becomes thick, especially at the bottom, and as carbon is a bad conductor of heat, the retorts lose in efficiency and the risk of burning out increases.

In section III attention has been drawn to the great need of temperature regulation during the course of the distillation. In some large retorts temperature readings are made regularly at one or two points in the retort by means of thermocouples. The retort is provided with iron tubes reaching to the middle of the retort and closed at their inner ends, and in these the thermocouples are inserted.

V.—Methods of Working up the Primary Products.

The actual products obtained from the retorts by the distillation are:—

(1) Charcoal, (2) Wood tar, (3) Pyroligneous acid and (4) Wood gas. The gas is used directly for heating purposes and the charcoal when removed from the coolers is in a marketable form.

The tar and pyroligneous acid, on the other hand, require further treatment before they can be regarded as saleable articles. The working up of these two products is carried out in the distillery as the freight charges on the crude pyroligneous acid would be too high to admit of its removal to a refinery at any distance from the distillery.

The methods of refining have now reached such a state of efficiency that in certain factories the conversion of the crude product into the pure material entails a loss of only one per cent. Improvements in the refining plant have also led to the reduction of the fuel consumption to about a third of its value when working with cruder plant. Such results are only to be obtained at the largest establishments working with the most modern plant, a description of which is beyond the scope of the present paper. It is only proposed here to give a brief account of the plant necessary for producing grey acetate of lime, acetate of soda, acetic acid, and wood spirit at the distillery.

The vapours, on leaving the still, are led through short wide pipes into the condenser. In factories where one condenser is used for several retorts the wide exit pipes from each retort lead into a main channel and in order to prevent the vapours from one retort passing into another, each exit pipe dips under a layer of distillate in the main channel. All pipes should be made of copper or cast-iron and should be sufficiently wide to be easily cleaned.

The types of condenser which have been adopted are the worm, the box and the tubular. The worm condenser has to be fairly wide in order to take the large volume of vapour and is somewhat inefficient as in a wide tube the gases not in contact with the walls of the tube take an appreciable time to cool and hence a considerable length of worm is required. The worm suffers from the further disadvantage that it is very difficult to clean. The box type does not suffer from this defect, as the wide condensing tube is bent on itself several times; the straight lengths of pipe are enclosed in a box through which the cooling water passes, but each return bend is outside the box and is fitted by a flange joint to the straight lengths and is thus easily removable for purposes of cleaning. As the vapours condense, the volume of gas passing through the condensing tube diminishes and hence the diameter of the tube can be gradually lessened in both this type of condenser and also in the worm condenser. A modification of this form of condenser consists in surrounding the

copper condensing tube with a wider iron cooling tube and passing a current of cold water between the two tubes and in a counter direction to the hot gases. In this modification also the return ends of the condenser tube are not cooled and are attached by flange joints to the straight tubes. The connection between the different lengths of cooling tube is by means of short connecting pieces.

In the tubular condenser the tubes are of much smaller diameter and a number are attached to a dome-shaped top into which the vapours from the retort pass, and to a box at the bottom in which the condensed liquid collects and passes into a separator. The whole of the interior part is made of copper and is placed in an iron or wooden vessel through which cold water is passed from the bottom to the top The dome must be sufficiently large to distribute the vapours, as they enter, without producing a back pressure.

The outlet tube from the condenser is attached to a separator in which the condensed liquid collects and can be run off automatically whilst the uncondensed gases are led away by a pipe.

Condensers should be carefully designed in order that they may work efficiently with the vapours from the particular retort to which they are to be attached, a point too frequently neglected.

It is very important that the condenser should cool the liquors thoroughly, otherwise an appreciable quantity of acetic acid, and even larger amounts of methyl alcohol are carried away with the permanent gases. For instance it has been shown* that, if during the violent exothermic reaction, the liquors are only cooled to 38°C. (100° F.) a temperature which is frequently the *minimum* obtainable in some parts of this country, about 5 per cent of the acetic acid and 45 per cent of the alcohol remain uncondensed. It is, therefore, absolutely essential in India, to pass the gases which leave the condenser through a scrubber, or tower filled with coke or stones, down which water or weak pyroligneous acid

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* J. C. Lawrence, J. Soc. Chem. Ind., 1918, 37, 131.

is running. With an efficient scrubber of this type nearly all the acid and alcohol can be recovered.

The condensed liquor is run into a series of vats in which it is allowed to settle. In Europe these vats are usually of wood and as the weight of distillate is roughly 50 per cent. of the weight of the charge of the retort, their capacity should be not *less* than about 350 gallons for every ton of wood distilled daily in order to allow for three days' storage. A seven days' storage is sometimes recommended.

After standing two or more days, the clear pyroligneous acid is run into a copper still heated by a steam coil and provided with a small fractionating column. On warming, practically all the methyl alcohol, together with some acetic acid, pass over first and are collected separately. Acetic acid and water distil next, while a residue of tar is left in the still. The latter is usually run into another still where steam is blown through it until all the acetic acid is removed. The final residue is of a nature different from the tar insoluble in the pyroligneous acid, and is usually burnt. The crude methyl alcohol is neutralised with lime or sodium carbonate and redistilled in a still with a fractionating column. The distillate is commercial wood spirit, while a solution of calcium or sodium acetate remains behind.

This solution is added to the bulk of the redistilled acid and the whole neutralised. Usually the solution is set aside for several days in wooden vats to clarify and is then concentrated. For this purpose, the simplest type of plant is a large steam jacketted pan in which the solution is boiled down until it becomes semi-solid. The pasty mass is then removed and the drying completed either on iron plates heated by the furnace gases, in special steam pans fitted with a stirrer, or by means of a revolving steam heated drum. In the case of acetate of lime the drying temperature must not exceed 150° as decomposition takes place at higher temperatures. The product is finally ground and forms the commercial grey acetate of lime. In the case of the sodium salt, the simplest method of obtaining a pure product is to stop the first evaporation just before the solution begins to get solid,

and run the liquor into a cast-iron pan fitted with a mechanical agitator, and heated over a free fire. The acetate first dries and then melts. If the temperature is raised to about 280° all the tarry matters are decomposed and charred, and the resulting mass when treated with water gives a nearly colourless solution with solid matter in suspension. The latter can be easily removed and the solution allowed to crystallise.

According to the method just outlined, the crude pyroligneous acid is first redistilled, and then evaporated. This requires a considerable amount of fuel, in fact, if the fuel used is wood with a calorific value of 3,500 calories working at 50 per cent. efficiency, the following amounts of fuel would be required for each 1,000 lbs. of wood distilled:—

Original distillation	150 lbs.
Redistillation of crude pyroligneous acid ...	154 lbs.
Concentration of acetate of lime to pasty consistence	112 lbs.

making a total of say 420 lbs. in addition to the combustible gases from the retorts.

Great economy would be effected if the original condensation could be conducted so as to produce a clear distillate free from tar, as the manufacture of grey acetate of lime would then consist of a simple neutralisation followed by evaporation, but so far there is no process for doing this which is altogether free from objection.

The methods described above are comparatively simple, and in England a plant operating in this way would be placed in charge of a foreman. Directly attempts are made to economise fuel, the plant becomes more complicated, and more expert supervision is required. It is probable that in this country the extra charges for establishment, interest on capital, depreciation, and patent licenses would far more than outweigh the saving in fuel.

Acetic acid, in a comparatively pure form, is not, generally speaking, one of the substances turned out *in situ* in a wood distillation factory, but rather a product of the refinery. It is proposed, however, to give a brief outline of its preparation, owing

to its importance in the east for use in the rubber industry, and also, in order to show that the process is by no means a simple one.

Acetic acid attacks all the commoner metals when exposed to the air, but copper is not affected in absence of air, hence it is usual to make all vessels in which acetic acid is to be treated of thick copper. For the purest kinds of edible acid, silver outlet pipes and condensers are necessary, so that the outlay on plant is considerable, and the depreciation of the copper vessels, if not in continual use, is very heavy.

The simplest and oldest way of making acetic acid is by treating acetate of soda with sulphuric acid. If the crystals are used and the whole distillate collected together, the product is an acid of about 50 per cent. strength. A more concentrated acid can be produced by using fused sodium acetate. The acid is finally redistilled in a steam heated copper still to remove impurities. This method is never used now except for making edible acetic acid, owing to its high cost as compared with other methods.

Ordinarily, grey acetate of lime is used as the starting material for making acetic acid. There are two main methods of treatment—(*a*) with hydrochloric acid, and (*b*) with sulphuric acid. In the first case the acetate is mixed with the acid in wooden vats or masonry pits and allowed to stand for twelve hours. The liquid is then run into a copper still, and heated either by a free fire or by steam coils. The liquid which distils contains 40 to 45 per cent. of acid, and contains chloride, while an appreciable amount of acetic acid remains behind in the still. This method would probably be impracticable in India for the present owing to the high price of hydrochloric acid.

The sulphuric acid process, which is now the most largely used, requires more expensive plant owing to the fact that calcium sulphate is insoluble, and when acetate of lime is treated with sulphuric acid a pasty mass is formed. Consequently mechanical stirrers are necessary and these require a considerable amount of power to drive them. A cast-iron pan, fitted with such a stirrer and heated by free fire, is used, and the acetate mixed with concentrated sulphuric acid. The acetic acid which distils contains

about 75 per cent. of acid, but it is also contaminated by considerable amounts of oily matter and sulphur dioxide, which result from the reaction of the tarry matter in the acetate of lime with the sulphuric acid. This decomposition involves the use of about 15 per cent. excess of sulphuric acid over the theoretical quantity.

A great improvement in the sulphuric acid process has been effected by the use of a vacuum still which may be heated by steam Owing to the lower temperature of the reaction, very little decomposition of tarry matter takes place, the product is much purer, and less sulphuric acid is required.

Another interesting method is that of Behrens This consists in dissolving the acetate of lime in acetic acid, and then treating *with sulphuric acid and filtering off the calcium sulphate. This has* the advantage of dispensing with the rather complicated vacuum apparatus, but the stages of the operation are more numerous. Both these methods give a fairly pure 80 per cent acid.

The acid obtained by any of the above processes is ordinarily rectified by distillation in a still with a fractionating column. The latter is frequently constructed partially of porcelain, although in view of the brittleness of this substance, its use is of questionable advantage as compared with copper Theoretically, acetic acid and water can be completely separated by fractional distillation, but in practice this is not the case. It is almost impossible by fractionation to obtain concentrated acetic acid from a solution containing 10 per cent. or less of acid even with very great expenditure of fuel; consequently it is usual to put the acid on the market in two forms (1) 98 per cent. "Glacial Acetic Acid," (2) 30 per cent. "Commercial Acetic Acid.' 100 lbs. of 80 per cent. crude acid, will give about 68 lbs. of the former and 27 lbs. of the latter, whereas 45 per cent. acid will give 21 lbs. and 76 lbs. respectively, The great superiority of the sulphuric acid process over the hydrochloric acid method, when glacial acetic acid is the product chiefly required, is thus evident. By another rectification each 100 lbs. of the 30 per cent. acid may be separated into 20 lbs. of 90 per cent. acid and 80 lbs of 15 per cent. but this is seldom done owing to the small demand for the latter strength of acid.

Finally the glacial acid is frequently redistilled to remove impurities, and slightly increase the strength.

It is evident that all these operations require a considerable amount of fuel. The quantity naturally varies very greatly with the exact type of plant used, but a rough estimate for a factory working the sulphuric acid process without a vacuum is about 5 cwt. of good coal for each ton of acetate of lime treated.

VI. Wood Distillation in India.

India's immense forests and her comparatively cheap labour would, at first sight, give the impression that the country is an ideal one for wood distillation on an enormous scale.

Before such a conclusion can be justifiably drawn the industry must be carefully studied in all its aspects.

Dealing with the questions of materials most suited for the wood distiller there is no doubt but that ideal sites for distilleries would be :—

1. In or near plantations where high grade timber is felled. An example of such a plantation is the teak plantation in Nilambur, S. Malabar.

The large trees are felled and all sound timber sold as such. At present the greater proportion of the loppings, etc., are left on the ground to rot. The only cost in such a case would be the sawing of such waste into pieces of suitable size for the retorts and the cost of carting to the actual factory.

In such plantations the wood removed in the course of thinning would also be available.

The cost of such wood should be appreciably lower than that of jungle trees cut for the purpose of wood distillation only.

2. Plantations of special types of timber grown for the purpose of wood distillation. These should be species which grow quickly and give a good charcoal in addition to fair yields of by-products. Species suited for S. India appear to be casuarina and for higher altitudes blue gum. In the case of different species of blue gum the recovery of the essential oil from the leaves could be carried out side by side with the distillation of the wood.

3. In large virgin forests. In working such a jungle for obtaining material suitable for wood distillation, attempts should always be made to dispose of as much of the big valuable trees for timber purposes as possible and to use the loppings of such trees and all materials unsaleable as timber for the retorts, otherwise the whole cost of felling and sawing large trees would have to be borne by the factory. Materials too small for the retorts can always be burnt in the furnace for heating the retorts. All the sawdust and waste can also be burnt for the same purpose in a specially constructed furnace.

It should be borne in mind that when only one species of wood is used in a factory then the charcoal obtained is all of the same grade. Teak and casuarina give excellent charcoal. Certain jungle woods, on the other hand, produce a soft, light charcoal of inferior quality.

In all cases the transport charges would be one of the chief factors controlling the cost of the wood. To reduce transport costs a system of light tramways for carting the wood from the forest to the factory would probably be necessary.

The following figures will give some idea of the gross receipts which could be realized by a factory distilling 6,000 tons of wood a year. The saleable products turned out by such a factory would be *(a)* charcoal, *(b)* grey acetate of lime, *(c)* wood spirit and *(d)* tar.

The London pre-war prices for grey acetate of lime and wood spirit were respectively Rs. 135 per ton and Re. 1-12-0 per gallon. The prices we have taken are: charcoal Rs. 20 per ton, grey acetate of lime Rs. 135 per ton, wood spirit Re. 1 per gallon and wood tar Rs. 30 per ton All these materials fetch far higher prices at the present time, *e.g.*, grey acetate is Rs. 675 per ton and wood spirit Rs. 12-8-0 per gallon, but prices will undoubtedly fall after the war. It is extremely difficult to draw definite conclusions regarding the post-war prices of many chemicals. It is obvious that numerous very large factories now entirely employed in turning out materials required for war purposes will then be occupied in manufacturing products for peace purposes. When it is borne in mind that the number of chemical factories, including

wood distilleries, in Britain, France, America, the British Colonies and Japan has been increased considerably during the last four years, it is clear that the few years after the conclusion of peace will be years of the keenest competition. This is already recognised in England; the Departmental Committee on Sulphuric Acid and Fertiliser Industries appointed by the Minister of Munitions recommend the scrapping of a certain proportion of the plant, especially such as is inefficient, and the compensation from public funds for such compulsory scrapping.*

A somewhat similar state of affairs may hold good in the case of wood distillation products, the quantities turned out may be rather more than the countries under peace conditions can utilize. This necessarily means an appreciable fall in prices of articles such as acetate of lime and wood spirit. On the other hand, it is highly probable that labour charges in Europe and America will never fall again to what they were in pre-war times. This has also been realized in England and the suggestion has been made that to compensate for higher wages a greater efficiency of machinery should be aimed at by running all machinery and plant for the full 24 hours by means of 3 shifts of labour. In the case of a wood distillation factory this latter factor does not come into force, as big retorts are worked practically continuously. It is largely a question then of the effects of large supplies tending to reduce and higher wages tending to keep up the prices.

In part II the yields of acetic acid and of wood spirit from some typical S. Indian woods are given and the values we have taken for purposes of calculation are 3.3 tons of acetic acid and 1·4 tons of wood spirit for every 100 tons of wood.

For each 100 tons of wood the following amounts would be realized :—

			Rs
23	tons	of charcoal at Rs. 20	560
5·8	do	grey acetate of lime at Rs. 135 ...	783
1·5	do	wood spirit (80 per cent.) at Re. 1 per gallon	420
6	do	tar at Rs. 30	180
		Total ...	1,943

* Chem. Trade J., 1918, 62, 203.

As 500 tons are distilled each month, the gross receipts would be Rs. 9,715 per mensem.

On the outgoing side the chief items would be the cost of wood and depreciation charges on the plant.

It is difficult to assign a uniform value for the wood as this must undoubtedly vary with the locality and with the type of wood used. Even in the case of wood felled for the purpose of distillation the cost should not exceed Rs. 5 per ton, and allowing 42 tons of fuel for each 100 tons of wood distilled, the monthly expenditure on wood comes to Rs. 3,550.

The cost of a plant for distilling 500 tons of wood a month may be taken as £8,000 to £9,000 in England or £10,000 to £11,000 delivered and erected, *i.e.*, Rs. 1,50,000 to Rs. 1,65,000.

The life of a retort is comparatively short, while copper condensers and stills do not last much longer. The depreciation would thus be relatively high and a charge of 20 to 25 per cent. per annum on the cost of the whole plant should be made. Taking the value of the plant at Rs. 1,65,000 and the mean depreciation charge as 22·5 per cent. this would give an annual charge of Rs. 37,125 or a monthly charge of say Rs. 3,100.

These figures leave a balance of Rs. 9,715 less Rs. 3,550 less Rs. 3,100 = Rs. 3,065 per mensem to meet other charges: such charges include:—rent, interest on capital supervision, office and labour charges, chemicals, water, repairs, etc. The sum should be sufficient to meet all these items of expenditure and to yield a profit in addition to the interest on capital. Any reduction in the cost of the wood or rise in the price of the products would increase these profits.

The calculation just given assume that the products obtained can all be sold at the prices given.

This aspect of the question deserves a little further study.

It is true that the Indian forests are immense, but it is also true that the most important ones, those of the Western Ghauts, the Himalayas and Assam are, generally speaking, in mountainous and inaccessible country. Apart from the fact that this means increased difficulty in felling and bringing the wood to the

factory, it also involves the finished products being carted long distances and then being sent still further by rail.

To deal with the products individually; the one offering the most difficulty is charcoal. If the distillation is carried out primarily for making charcoal for iron smelting or other industrial purposes, as is proposed in Mysore, this difficulty does not arise but in normal cases where it is a question of utilizing wood waste to the best advantage, the disposal of the charcoal will not be easy. A small distillery would have no difficulty in finding a local market, but as the distillery grows in size, the difficulty of selling the charcoal will be increased far more than proportionately. Charcoal is light and carries badly, so that briquetting would be necessary if it were to be sent any distance. Consequently the question resolves itself into one of freight, as far as South India and Bombay are concerned, while in Bengal, there would be the additional difficulty of cheap coal as a competitor for many purposes.

With regard to acetates, there is a certain demand for these substances in the country in cotton mills and dyeing establishments, while a considerable quantity could be converted into acetic acid. One of the chief use for grey acetate of lime was for the manufacture of acetone, but, as already stated, acetone can now be obtained by the fermentation of cereals and the question is largely one of the relative costs of the two methods.

Wood spirit, although used in enormous quantities in Europe for denaturing alcohol is not utilized for this purpose in India, probably owing to its scarcity. It is possible that a demand for it for this purpose might arise if a steady supply could be assured, while, in any case, considerable amounts would probably be absorbed for making varnishes.

The disposal of wood tar is always a matter of some difficulty. A limited amount might be used for disinfecting purposes although greatly inferior to coal tar, and another possible use appears to be for the tarring of roads, as a few small scale experiments have shown that it as good as, or even superior to, coal tar for this purpose. Failing these uses, a certain quantity could

be used in briquetting the charcoal and the residue would have to be utilized as fuel.

With regard to acetic acid, there is undoubtedly a large demand for this in the East for rubber coagulation, but the product used almost exclusively at present owing to costs of transportation is the glacial acid (98 per cent.) and consequently it would be difficult to dispose of the dilute acid which is always produced along with the concentrated. It would probably be necessary to convert this dilute acid into salts, such as iron and lead acetates which could then be exported.

Considering this question of the disposal of the products as a whole, it seems probable that a few small factories would be able to sell the whole of their output without difficulty, but any overdevelopment of the industry might only end in disaster.

The following figures taken from the Bulletin of the Imperial Institute (1916, 14, 567) give the average imports, for the years 1913—15, of wood distillation products into Britain :—

Acetate of lime	... ...	4,750 tons.
Acetic acid	... ...	4,280 „
Acetone	. ...	3,490 „
Wood spirit	... ...	589,210 galls.
Wood tar	.. ...	13,160 tons.

In the case of tar about 8 per cent. was re-exported, but practically all the other products were consumed in the United Kingdom.

It is clear that the forest resources of the British Isles would be inadequate to meet these demands, even if the industry were increased to its full extent. This means that there will always be a market in Britain for most of the products. Canada and the United States supply the great bulk of the acetate of lime, acetic acid and wood spirits, and Russia and Sweden most of the wood tar. In 1913 Austria supplied large quantities of acetone but in 1915 the great bulk was imported from America.

The chief problem for the wood distiller in India is, can he turn out his products at prices that will enable him to compete with the American and European distiller? To compensate for the

high freight charges between India and England he will have to manufacture his products at a cost rather below the average American or European cost.

This necessarily means extremely careful selection of sites for factories and the provision of cheap raw materials, including wood, lime and sulphuric acid. The factory must be near a cheap supply of wood of suitable quality, it should be near a market for all the charcoal made, and proximity to a port is desirable in order to reduce to a minimum the freight charges on all products exported.

VII.—Softwood Distillation.

The whole of the preceding sections have dealt with the process known generally as "Hardwood Distillation" and in Europe and America it is the method adopted for different types of deciduous trees rich in ligno cellulose material.

Another important branch of the wood distillation industry is the one known as "Softwood Distillation" or coniferous wood distillation; and deals with woods containing resinous materials and oils in addition to water and ligno-celluloses. Softwoods of this type, for example pine, fir and spruce, yield large quantities of crude tar and only small quantities of acetic acid and wood spirit in comparison with the amounts produced from hardwoods.

In N. America and Scandinavia the distillation of soft woods has developed into a very large industry and includes the production of resin, pine oils, turpentine, and resin spirits. At the present time this industry does not appear to be so adapted to the needs of India as the hardwood distillation industry and we do not propose dealing with it in detail

The methods of distillation are not the same as those in the hardwood distilleries and the products and the methods of refining them are also different.

Distillation with superheated steam and extraction with a solvent are frequeny used as well as the older method of distilling from fire-heated retorts. A brief account of some of these methods will be found in Lawrence's paper in the Journal of the

Society of Chemical Industry (1918, 37, 5T, and an account of suitable plant in W. B. Harper's "Utilisation of Wood Waste by Distillation" (1907).

A full account of the method of tapping species of pine for the oleoresin and the manufacture of resin and turpentine from the oleoresin will be found in the Indian Forest Bulletin No. 26, 1914, by E. A. Smythies.

EDITOR'S NOTE ON MESSRS. WATSON AND SUDBOROUGH'S TREATISE ON WOOD DISTILLATION.

The conclusions arrived at in the above report clearly demonstrate the possibilities and limitations of wood distillation in India. The proposition is to manufacture (*a*) Charcoal, (*b*) Grey acetate of lime, (*c*) Wood spirit and (*d*) Tar. The financial position is based on the assumption that wood will be available at Rs. 5 per ton or less and on pre-war rates for the derived products. The most important factor is that during the war many new distilleries have come into existence all over the world, the products from which were formerly absorbed for war purposes, and which now will have to find other markets thus raising brisk competition, resulting in low prices. Taking these factors into consideration, together with high freights, were export contemplated, we do not consider the present a favourable time for pioneering this industry in India, unless the work is started under very favourable conditions, as for instance in conjunction with the Mysore Iron Smelting Scheme.

The line which we strongly advocate should be taken by the Forest Department is to improve the methods of preparing charcoal in the forests and to reduce charcoal to a more portable form. We cannot deal here with the various methods of preparing charcoal, as it will be necessary to carry out a full investigation into the subject, with the object of devising standard kilns most suitable to locality and species of timber.

Such work will naturally be carried out by the Minor Forest Products Expert, when appointed, by provincial utilization officers or by special officers under their control. The enquiry is one of the greatest importance and must be started with as little delay

as possible, as not only is the question of the charcoal supply involved, but it is closely connected with the utilization of waste wood resulting from intensive management.

Closely connected with the above subject is the question of reducing charcoal to a more portable form. The solution probably lies in briquetting charcoal when reduced to powder, as by grinding up charcoal its bulk is reduced by half while compressing the dust into briquettes again reduces it by half. In the *Indian Forester* for March 1918, a short article appeared dealing with some initial experiments carried out at the Forest Research Institute. These experiments could not be continued until a suitable experimental briquetting plant was available. Such a plant is now being erected and it is hoped to start further experiments without delay. The points to be determined are (i) the most suitable and cheapest bond for briquetting, (ii) the pressure required and (iii) the fineness to which it is necessary to grind the charcoal. There is one other point which requires study and that is the question of separating earth and other foreign matter from charcoal dust, which occurs as waste material in charcoal depôts. Plans have been obtained of a possibly suitable lixiviation plant, in which to separate the earth from the charcoal, an experimental model of which will be prepared and the necessary preliminary experiments carried out in the near future.

THE FORESTRY BILL.

In continuation of previous extracts we reproduce from *Nature* of August 14th, 1919, further notes on the Forestry Bill which has now passed through the House of Commons. It is satisfactory to note that the defects in the original Bill have been dealt with and removed in the Commons and we congratulate Sir Philip Magnus on the results of his labours.

The Forestry Bill came before the Commons in Committee of the whole House on August 8th, when amendments to several of

the clauses were suggested. An important amendment increased the number of Commissioners from seven to eight, with the object of having one unpaid Commissioner sitting in the House of Commons, thus enabling the House to keep itself acquainted with the progress of the afforestation work. This amendment was agreed to, as was also another by Major W. Murray that not fewer than two of the Commissioners should have special knowledge and experience of plantation and forestry in Scotland.

Sir Philip Magnus strongly advocated the view put forward by the British Science Guild that at least one of the Commissoners should be a person of scientific attainments having a technical knowledge of forestry. This amendment was rejected on a vote, but Sir Philip persisted with it in the Report stage, which followed immediately after Committee was over and it was then accepted and added to the Bill. He also put forward an amendment, which was accepted, that the Commissioners should have power, in addition to collecting and preparing forestry statistics, to publish and distribute them.

From the point of view of assuring that the new Forestry Authority should have expert guidance in inaugurating and formulating its forest policy, the acceptance of Sir Philip Magnus' amendment with reference to the inclusion of expert scientific opinion on the Commission is of the very first importance, for on that member will lie a heavy responsibility. It is to be hoped that in his selection the Commissioners will make every effort to secure a man of recognized scientific attainments and merit, who at the same time possesses a wide knowledge of up-to-date forestry methods as existing in the different forestry services in the world. The appointment will not be an easy one to fill.

To those acquainted with the requirements of a truly scientific forestry department, the setting up of which is arrived at in this country, Sir Philip's other amendment, with reference to the publication of forestry statistics, which was also urged by the British Science Guild, is of not less importance. The publication of the material collected in proper form—that is, in a form which shall comprise the issue of that collected in a separate series of

publications, some for the scientific reader, and others for the lower grades of a forestry service and for laymen—is a matter of supreme importance. This importance is accepted by the man of science without question, but to the public the value of such reports is not self-evident. In this respect, therefore, the House of Commons is to be congratulated on possessing at least one member having the knowledge and foresight to recognize the vital necessity of assuring that this aspect of the question is safeguarded, and to be an advocate of scientific interests generally.

After passing through Committee the Bill was read a third time.

THE EFFECTS OF FORESTS.

Although it remains open to doubt if the presence of forests increases rainfall, no doubt whatever remains that their absence prejudicially affects the flow of rivers. We see this emphasized in a letter to the "Surveyor" by the City Engineer of North Vancouver, B. C., whose work gave him ample opportunities of studying the hydrography of the watershed whence the city water-supply is derived. He concludes (1) that the tall trees retard materially the spring melting of the snow, (2) that the forest and ground vegetation maintains a normally low temperature in summer, preventing excessive evaporation and keeping the ground well saturated with water, (3) that the forest growth prevents erosion and quick run-off on steep slopes. There is the record of a careful test with two basins, one of 140 acres completely wooded, the other of 175 acres very scantily wooded. The first showed a maximum outflow after heavy rainstorm of from 30 to 50 per cent. less than the second; and, on the other hand, during long periods of drought gave a flow of water without interruption while the second had run dry.—[*Indian Engineering.*]

AS OTHERS SEE US.

The following extract from the *Field* of September 27th, 1919, is illuminating in displaying the opinion of a leading country newspaper regarding the suitability of officers of the Indian Forest Service for Home employment. We know that the interim forest authority has been endeavouring to secure the services of Indian officers and that it has met with only a small measure of success. It is significant that in the general scramble for posts a preference should be given to Indian forest men and that the interim forest authority should actually apply for their services. Few " decent conservators " are willing to take subordinate positions under the control of an authority composed chiefly of men who have had no administrative experience and no training in the theory or practical application of forestry.

The course undergone by our probationers is the best that can be devised for foresters in any part of the British Empire as it aims chiefly at developing accurate habits of observation upon which to base sylviculture and sound management. Theser essential attributes are not, by any means, lost in the course of service in India, they are further developed. It is essential in India as elsewhere to make the best use of the soil and we have no misgivings regarding the capabilities of the few Indian officers who take up Home employment to render a good account of themselves.

The *précis* of the Forestry Act, 1919, will be of interest to those who have read the preliminary discussions which have already appeared in this journal.

State Forestry at last.—Below is a *précis* of the new Forestry Act which came into operation on the first of this month. On the whole the provisions of the Act are satisfactory. It promises a good beginning, and we have little doubt that if administered in a proper spirit it will lay the foundation of "a real and assured and established industry of the State." Much will depend upon the selection of officers. With respect to the Commissioners, the three that are to receive salaries ought certainly to be men who have a knowledge of forestry, and are in full sympathy with the desire for its vigorous promotion in the British islands. The selection of officers to work under the Commissioners is of vital importance, and we therefore regret to hear from a trustworthy source that there is some danger of bad judgment being exercised in this matter. It is even said that preference is being shown for men whose only qualification is that of having served in some forestry capacity in India or the Colonies. If there were no qualified men among those who have had experience in the United Kingdom there would be an excuse for this. But there are many, and if the selection were left to a committee of such men as Dr. Somerville, Sir John Stirling Maxwell, Sir K. J. Mackenzie, Mr. J. F. Annand, Mr. Acland, Major Courthope, and Mr. H. J. Elwes, a team of efficient officers would be found. Forestry in this country required for its success men with very different qualifications from those which make a decent conservator of forests in India, where nature has done, and continues to do, most of the planting. Commercial forestry, we might almost say intensive forestry, is our great need now, and for this alert men with a knowledge of the best methods of forest management should be secured. Under their upervision the rank and file of workers or

woodmen would be employed to advantage. The mistakes made in not a few Government Departments during the war owing to the appointment of ill-chosen officers ought not to be repeated by the Forestry Commission. That there is a keen scramble for the posts is evident in the fact that six months ago over 2,000 applications had been received for at most some eighty posts which have to be filled, and we know that a considerable number of the applicants possessed no other qualification than a desire for a healthy comfortable job under Government. Their idea is that any intelligent person can plant and look after trees, whereas it requires as much study, observation, and practice to make an efficient forester as it does to make an efficient medical practitioner or a captain in the King's Navy. Whilst we are heartily glad to get the Forestry Act which makes provision for the planting of 200,000 acres with timber trees, and to assist landowners who desire to follow the Government's example, we trust no mistake will be made over the staffing of the department. A good start means so much in forestry.

The New Forestry Act.—The following is a *précis* of the Forestry Act, 1919, which came into operation on September 1st. It is described as "An Act for establishing a Forestry Commission for the United Kingdom, and promoting afforestation and the production and supply of timber therein, and for purposes in connection therewith."

(1) To appoint eight Forestry Commissioners, two to have special knowledge and experience of forestry in Scotland and one at least to have a scientific and technical knowledge of forestry. Not more than three Commissioners to be paid, their combined salaries not to exceed £4,500 per year. The term of office of a Commissioner to be five years. On a casual vacancy occurring the vacancy to be filled *pro tem.* by a person appointed by the King. Commissioners to be eligible for reappointment. One of the unpaid Commissioners to be a member of Parliament.

(2) The Commissioners to appoint such paid officers and servants as they think necessary, under Treasury sanction.

(3) The powers and duties of the Boards of Agriculture for England, Scotland, and Ireland in relation to forestry to be transferred to the Commissioners, unless otherwise mutually agreed. The Commissioners to have power to purchase or take on lease and hold any land required for afforestation; to sell or let land unsuitable, or exchange it for other land that is more suitable; to purchase standing timber, sell, or otherwise dispose of timber belonging to them, to make advances by way of grant or loan to persons in respect of afforestation; to undertake the management or supervision on agreed terms, or give assistance or advice in relation to the planting or management of any woods or forests belonging to any persons; to establish or assist woodland industries; to collect and publish statistics and information relating to forestry; to make inquiries for the purpose of securing an adequate supply of timber in the United Kingdom.

(4) The Commissioners to have power, on notice being given to an occupier of land, to destroy rabbits, hares, or vermin likely to damage trees or tree plants and to recover the cost incurred from the occupier.

(5) Three Assistant Commissioners, one for England and Wales, one for Scotland, and one for Ireland to be appointed, at salaries to be determined by the Treasury.

(6) Consultative committees for England, Scotland, Ireland, and Wales respectively to be established by Order in Council, to advise and assist the Commissioners.

These committees to consist of persons having practical experience relating to forestry, woodcraft, and woodland industries; representatives of labour, of county councils, of forestry societies, and of woodland owners.

(7) If unable to acquire land by agreement on reasonable terms, compulsory powers to be obtained from the Development Commissioners, but no land to be acquired compulsorily which forms part of any park, demesne, garden, or pleasure ground, part of a home farm, or has been acquired for a public undertaking. Common land, if compulsorily acquired, to be held provisionally until confirmed by Parliament, except other land of at least the same area and certified as suitable by the Board of Agriculture be given in exchange. Facilities for the haulage of timber to be afforded, on order if necessary, the amount of rent or way-leave to be assessed by an arbitrator appointed by the Surveyors' Institution.

(8) Salaries and all expenses to be defrayed out of the Forestry Fund, the amount of which is fixed for the first ten years, from April 1st this year, at £3,500,000, plus all sums received in respect of the sale of land or timber.

(9) Authorised persons may enter on and survey any land for the purpose of ascertaining whether it is suitable for afforestation, or to inspect timber thereon, or for any other purpose in the performance of the duties of the Commissioners under the Act.